

Evaluation of Material Management Methods in Selected Building Construction Sites in Abuja and Lagos State, Nigeria

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Abstract: The study appraised the degree of necessity and usage of material management methods adopted by small-scale construction firms in Abuja and Lagos State, Nigeria. It identified and examined the factors affecting material management practices, and assessed material management-related factors influencing cost variance. Eighty (80) structured questionnaires was administered on sites supervisor/manager through purposive sampling. Data obtained were analyzed using frequency, percentages, Mean score and relative severity index. The study revealed the most important material management method as site planning and organization (4.95), while employment of security (4.88) was often adopted for effective material management. The study found the most severe factors affecting material management as poor site organization, non-availability of material on sites, material not delivered as per schedule with severity index of (0.958), (0.948) and (0.928) respectively. Inadequate storage facilities (3.69), damaged materials (3.65), Loss of material (3.54), were found as material management factors most influencing cost variance. The study therefore recommends that; proper site organization should be carried out on construction site; materials should be made available on-site with required quantities and delivered as at when due with adequate stacking and storage facilities. More so, there should be adequate storage facilities on construction sites, material damage/ loss of material should be reduced to the barest minimum. The service of a good estimator should be engaged by the firms to mitigate against inaccurate/poor estimation of materials.

Keywords: Construction, Evaluation, Material, Management, Method

1. Introduction

The average material cost is 55-60% of total construction project cost, hence, efforts should be taken to reduce material cost [1, 2]. It has also been pointed out that effective materials management on the construction site is important for project success [3]. According to Ayegba, Material management is the process that coordinates planning, assessing the requirement, sourcing, storing and controlling of materials, purchasing, transporting, minimizing the wastage and optimizing the profitability by reducing the cost of the material [4]. Patel *et al.*, noted that the goal of material management is to ensure that correct quality and quantity of construction materials that are obtained at a reasonable cost are available at their point of use

when needed [5].

Aiyetan *et al.* and Adewuyi *et al.* roved that the practice of material management by construction firms in Nigeria is extremely poor, this menace could impede the productivity of many construction projects in Nigeria [6, 7]. Adewuyi *et al.*, further demonstrate that ineffective management of materials on sites could lead to poor performance and undesirable project outcomes as well as the poor public image of the construction industry in Nigeria [8]. Thus, poor materials management can result in increased project costs/ cost overrun during construction.

Saidu *et al.* defines cost overrun as a situation where the final cost of a project is more than the initial estimates [9]. Hence, Cost overrun of some items at the construction stage may lead

to an increase in the total project cost and minimize profit [10]. It is, however, necessary to implement some control method to enhance effective material management on the construction site and thereby reducing cost overrun to maximize profit [4]. Effective management of materials on sites will minimize wastage, save cost and increases productivity [11, 12]. Main factors influencing cost variance/overrun in construction material management include; overstocked materials, damaged materials, loss of materials, late arrivals of the materials to its location, double handling of materials, inflation, changes in buying/purchasing situation from the prepared estimation, the shortages and changes of materials quantity required, materials inefficiency, pilfering and loss, loss of material shipment, work repairing, delay in updating/posting storage system, inaccurate measurement of work location, material off-take, inaccurate estimation of shipment quantity, uneconomic order quantity, poor shipping time, inadequate tools/equipment needed, increasing transportation cost, material over usage in location, choosing the wrong materials, the increasing storage cost, the poor buying ability, delay in payment, and the poor policy in purchasing. [13-16].

Patil et al. noted that poor planning and control of material, lack of material when needed, and poor identification of material, re-handling and inadequate storage affects material management practice and cause losses in labour productivity and overall delays that can indirectly increase the total project cost [17]. Ayegba in his study further identified that damage by mishandling, delay in material supply, inadequate supervision, poor site security, Weather and other natural occurrences, rework, alteration of designs, over-ordering of construction materials, theft and Vandalism are the major factors that affect material management on building construction sites [4].

It, therefore, follows that monitoring and planning of material schedule; the practice of security measures on-site; implementing good business relations with suppliers; use of information communication technology; and also use of qualified workers as well as effective workers' training for effective material management on construction site has a direct effect on construction project delivery success [3]. Hence, this study examined the perception of construction professionals on the degree of necessity and usage of the methods of material management among small-scale construction firms in Lagos State and Abuja, Nigeria, it also assessed the factors affecting construction material management practices in the study area and established the degree of severity these factors have on construction sites material management in the study area. And assessed Material management-related factors influencing cost variance/overrun in the construction projects.

2. Literature Review of Previous Studies on Material Management

Ayegba assessed the method of material procurement

practice on construction site, examined factors affecting material management on building construction site and determining causes of wastages on construction sites [4]. While Gulghane et al. carried out a systematic literature review on the management of construction materials and construction waste [18]. The study identified factors affecting material management but was however not subject to empirical test. Ngwu, et al. study was to identify the key areas where material management is deficient so that improvement could be made to increase productivity. Patel et al. analyzed the factors affecting Material management and Inventory management of 80 respondents from various construction firms of the Gujarat region [5].

Arijeloye et al. examined material management practices on building projects, issues related to material management and the means for managing materials in building projects in Ondo State [20]. Kulkarni et al. analyzed the factors affecting effective materials management in building construction projects [2]. The study revealed that the large firms were good & capable enough in applying material management techniques on construction sites. While the medium firms have some technical as well as some seasonal problems as they don't use any software, and the small firms lack behind in material management as compared to medium & large firms because of their limited knowledge about material management. Pratik, et al. identified the salient influential factors and categorized them based on their specific group as (1) site condition; (2) planning and handling on-site; (3) management; (4) materials; (5) supplier and manufacturer default; (6) transportation; (7) contractual; and (8) governmental interferences [21].

Veronika et al. identified major causes of cost variance in terms of the material, equipment, manpower, subcontractor, overhead cost, and general condition. Their works focused on Material being the main component in construction projects cost and recommended preventive actions to correct material variance [16]. Jusoh et al. reviewed the literature on the implications of material management on project performance. The study identified the effects factors of material management on project performance [21].

Pratik et al. carried out a literature survey to examine different material management practices adopted on sites and discusses their advantages and disadvantages affecting the economy of the project [22]. Kuebutornye, et al. identified and assessed the material management techniques required for construction firms in the Tamale Metropolis of Ghana [3]. The study, therefore, found that an increase in the number of material management methods adopted on a project will result to increase in the project delivery success. Madhavarao, et al. examined the techniques for material management for the construction project by using S curve, ABC Analysis for a clear understanding of the management of four important construction materials [12]. The study found an optimized way to reduce the cost of the project. Using the S-curve technique, and determined the number of materials procured using A-B-C analysis. Although a lot of researches have been carried out in the area of material management on building construction sites,

there is a perception among construction professionals that construction companies especially the small and medium are still having issues with their material management in Abuja and Lagos State, Nigeria. Therefore, this study examined the degree of necessity and usage of material management methods adopted by small-scale construction firms in Abuja and Lagos State, identified and quantified the strength of the factors as it affects material management practices in the study area, and assessed material management-related factors influencing cost variance/overrun on building construction sites in the study area [19].

3. Methodology

The survey research was undertaken in Lagos State and Abuja, Nigeria on the premise that most of the construction firms and construction professionals in Nigeria are either based in the Lagos States or Abuja and either has their branches located in Lagos or Abuja, Nigeria [23, 24]. The population of the study comprised small-scale construction firms involved in the construction of both public and private building construction projects in the study area. In Nigeria, small scale construction firms are categorized as firms that have a total asset of less than 50 million Naira, with less than 25 employees as a permanent staff [25]. The choice of the small-scale construction firms for this study is on the premise that material management problems will be more prevalent in the small-scale construction firms because of their limited knowledge in material management practices [2] and that they have a poor firm organization structure that can effectively handle issues in material management on building sites.

The population of the study is construction professionals which are site managers/ supervisors in some selected building sites in the study area. A total of eighty (80) well-structured questionnaire administered through a purposive technique to the targeted respondents was used. A total of fifty-eight (58) questionnaire was returned (Abuja 23, Lagos State 35) out of the eighty (80) questionnaire that was administered to the respondents, this gives a rate of return of 72.5%. The questionnaire sought to gather information about the respondents, organizational background and projects' characteristics. It also contains questions to know the perception of the respondents on the material management methods, the degree of necessity and usage of the material management practices, the factors affecting material management practices on building construction sites and factors influencing cost variance/overrun in the construction projects as a result of poor material management.

The data obtained were analyzed using descriptive statistics such as frequency, percentages, Mean Items Score (MIS), and relative severity index. However, frequency and percentage were used to analyze the data regarding the respondents, organizations and projects' characteristics, while mean item score was used to rank the respondent perceptions on the degree of necessity and usage of material management methods, material management-related factors influencing cost variance/overrun in the construction projects, and

severity index was used to ranks the factor affecting material management practices in the study area

$$MIS = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{n_5 + n_4 + n_3 + n_2 + n_1} \quad (1)$$

Where n is the frequency of each of the rankings.

Constant weights were assigned to each response in the questionnaire (ranges from 1 for Not important, 2 for less important, 3 for important, 4 for very important and 5 for extremely important). A cut-off point means score > 2.5 on a 5-point Likert-type scale have been declared to be sensible to decide critical or noteworthy variables [26]. Consequently, Opawole et al. prescribed 3.50 cut off point on a 5-point Likert-type scale, this was thought to be high when contrasted and different entries [27]. This paper embraced ≥ 2.5 mean scores as a cut-off point.

$$S. I. = \frac{\sum_{i=1}^5 a_i n_i}{5N} \quad (2)$$

Where: a=constant expressing the weight assigned to each response (ranges from 1 for No Severe, 2 for less severe, 3 for severe, 4 for very severe and 5 for extremely severe), n=frequency of each response, N=total number of responses [28].

4. Results and Discussion

Table 1. Years of Company's operation.

Description	Frequency	Percentage
6 – 10 yrs	7	12.1
11-15 yrs	22	37.9
16-20 yrs	18	31.0
Above 20yrs	11	19.0
Total	58	100

Table 1 above represents the years of operation of the company. This shows that 87.9% of the companies sampled have been involved in construction activities in Nigeria for more than ten (10) years and possesses the required experience in the industry to be able to contribute their quota effectively in the study

Table 2. Profession of Respondents in the Construction industry.

Designation	Frequency	Percentage
Architects	14	24.1
Builder	15	25.9
Engineer	23	39.7
Quantity Surveyor	6	10.3
Total	58	100

Table 2 above represent the Profession of Respondents in the Construction industry. This shows that the respondent cut across the various professional who possesses the required knowledge about the subject matter under survey to contribute their quota effectively in the study.

Table 3. Respondents Working Experience.

Designation	Frequency	Percentage
0-5 yrs	14	24.1
6-10 yrs	15	25.9
11-15 yrs	23	39.7
16-20 yrs	6	10.3
Total	58	100

Table 3 above shows the number of years of respondent working experience in the study area. This shows that 75.9% of the respondent sampled have spent over 5years in the construction industry and as such they possess relevant experience in the industry to be able to respond to all questions asked.

Table 4. Nature of work undertaken.

Designation	Frequency	Percentage
Public	15	25.9
Private	43	74.1
Total	58	100

Table 4 above shows the nature of work undertaken by various firms sampled. 25.1% executed public works and 74.1% undertook private works. This shows that majority of the small-scale construction firms may not have the financial capability and organizational know-how to undertake governments' projects.

Table 5. Type of Program Chart Used for Project.

Designation	Frequency	Percentage
Gantt Chart	40	69.0
Critical Path	8	13.8
Flow Chart	9	15.5
Gantt Bar Chart & Critical Path	1	1.7
Total	58	100

Table 5 above shows the various types of program charts used for projects by various firms sampled. 69.1% used Gantt chart, 13.8% used critical path, 15.5% used flow chart and 1.7% used Gantt bar chat and Critical Path. This shows that majority of the small-scale construction firms make use of Gantt chart for their construction planning and programme of work because it is the simplest and easy to understand by all construction professionals.

Table 6. Number of executed projects within the last five years.

Designation	Frequency	Percentage
0-10	23	39.7
11-20	35	60.3
Total	58	100

Table 6 above shows the number of executed projects within the last five year by various firms sampled. 39.7% executed between 1-10 projects within the last five years and 60.3% executed between 11-20 projects within the last five years. The implication of this is that 70% of the firms sampled have executed more than ten (10) construction projects in the last five years and that they possess the requisite experience and knowledge in the handling of construction materials to contribute their quota in this study.

Table 7. The person in charge of managing construction materials.

Designation	Frequency	Percentage
Company's director	4	6.9
Project manager	43	74.1
Site supervisor	11	19.0
Total	58	100

Table 7 above shows the person in charge of managing construction materials by various firms sampled. The implication of this is that 93.1% of construction materials purchasing and handling were carried out by site project managers and supervisors.

Table 8. What is the percentage cost of the materials to the total cost of the projects?

Designation	Frequency	Percentage
21-30%	6	10.3
31-40%	9	15.5
Above 40%	43	74.1
Total	58	100

Table 8 above shows the percentage cost of the materials to the total cost of the projects by various firms sampled. The implication of the percentage cost of the materials to the total cost of the projects is above 40% in most of the construction firms sampled. This reveals that the cost of the construction materials will go a long way in determining the total cost of the construction project.

Table 9. Respondent perception of the degrees of the necessity of material management methods.

NO	METHODS	MS	Rank
1	Site planning and organization	4.95	1
2	Employment of security measures on-site to safeguard material on site	4.91	2
3	Recording of usage and inventory of material during construction	4.76	3
4	Preparing and monitoring of material schedule	4.69	4
5	Stock control and storage techniques	4.40	5
6	Performing material variance analysis	4.40	5
7	Good supervision	4.36	7
8	Quality control and checking	3.98	8
9	Education and incentives schemes	3.95	9
10	Site communication	3.62	10

The result of the analysis of the respondent's perception of the degrees of the necessity of material management methods is presented in Table 9. This shows that the degree of necessity of the materials management methods listed were all relevant and important to the respondents. However, Site planning and organization has the highest rating by the respondents with a mean score of 4.95, followed by, employment of security measures on-site to safeguard material on-site with a mean score of 4.91, recording of usage and inventory of materials during construction with a mean score of 4.76 and preparing and monitoring of material schedules with mean scores of 4.69 while Site communication has the least rating with a mean score of 3.62. This implies that the most important methods based on the degree of necessity of material management methods according to respondent's perception is Site planning and organization while Site communication is the least

considered. These findings agree with Kuebutornye, et al., Patel et al. and Abdul-Rahman [3, 5, 13].

Table 10. Respondent perception of the degrees of usage of material management methods.

NO	METHODS	MS	Rank
1	Employment of security measures on-site to safeguard material on site	4.88	1
2	Recording of usage and inventory of material during construction	4.76	2
3	Good supervision	4.14	3
4	Site planning and organization	4.09	4
5	Preparing and monitoring of material schedule	3.74	5
6	Stock control and storage techniques	3.60	6
7	Education and incentives schemes	3.33	7
8	Performing material variance analysis	3.24	8
9	Quality control and checking	2.98	9
10	Site communication	2.34	10

Table 11. Factor Affecting Material Management Practices.

NO	FACTORS	MS	S. I.	Rank
1	Poor site organization	4.79	0.958	1
2	Non-availability of materials	4.74	0.948	2
3	Material not delivered as per schedule	4.64	0.928	3
4	Nonstandard specifications	4.57	0.914	4
5	Non-availability of quantity required	4.55	0.910	5
6	Inadequate stacking and insufficient storage on site	4.54	0.908	6
7	Using unsuitable places for storing materials	4.48	0.896	7
8	Incomplete drawings	4.41	0.882	8
9	Sole supplier	4.41	0.882	8
10	Improper material storage	4.40	0.880	10
11	Undefined scope; no good definition of what is wanted	4.28	0.856	11
12	Insufficient instruction about storage	4.22	0.844	12
13	Inappropriate storage leading to damage or deterioration	4.17	0.834	13
14	Lack of conformance to requirement	4.10	0.820	14
15	Wrong information about the supplier	4.05	0.810	15
16	Incorrect quantities delivered	3.98	0.796	16
17	Poor communication between parties	3.97	0.794	17
18	The capability of the supplier in the market	3.88	0.776	18
19	The incorrect type of material delivered	3.84	0.768	19
20	Lack of required information about the supplier	3.84	0.768	19
21	Incorrect sizes delivered	3.83	0.766	21
22	Incomplete / ineffective meeting	3.76	0.752	22
23	Lack of penalty measures against defaulted suppliers	3.62	0.724	23
24	Prevailing political conditions	3.50	0.700	24

The result of the analysis of the respondent's perception on the degrees of usage of material management methods is presented in Table 10. This shows that the respondent considered 8 methods out of 10 methods of materials management listed in their degree of usage as being important and 2 methods were rated as less important. It is shown in Table 10 that the mean scores of the rating of the degrees of usage of materials management methods on construction sites in ranges between 2.34 and 4.88. Employment of security measures on-site to safeguard materials has the highest rating with a mean score of 4.88, followed by the recording of usage and inventory

of material during construction with a mean score of 4.76, good supervision with a mean score of 4.14 and site planning and organization with a mean score of 4.09 while Site communication has the least rating with a mean score of 2.34.

Table 11 presents the rating of the respondents' perceptions on the severity of factors affecting material management practices on construction sites. This shows that the respondents rated all the twenty-four factors affecting materials management practices as severe. Poor site organization was rated the highest severe factor with severity index of 0.958, followed by non-availability of material on sites with a severity index of 0.948, material not delivered as per schedule with a severity index of 0.928, non-standard specification with a severity index of 0.914, Non-availability of quantity required with a severity index of 0.910, Inadequate stacking and insufficient storage on-site with a severity index of 0.908, Using unsuitable places for storing materials with a severity index of 0.896, incomplete drawing and sole supplier was rated with the same severity index of 0.883 and Prevailing political conditions is rated as least severe factor with severity index of 0.700. Notably, all the factors have a severity index > 0.699, which suggests that all the factors have a major as opposed to a minor impact in terms of affecting material management practices. These findings agree with Arijeloye et al. [20].

Table 12. Material Management related Factors influencing Cost Variance/Overrun in building construction Projects.

NO	Factors	MS	RANK
1	Inadequate storage facilities	3.69	1
2	Damaged materials	3.65	2
3	Loss of material	3.54	3
4	Inaccurate or poor estimation of the original cost	3.43	4
5	Pilfering of materials on site	3.38	5
6	Overstocked materials	3.31	6
7	Under ordering of material	3.29	7
8	Poor handling of materials on sites	3.25	8
9	Inflation of material costs	3.24	9
10	Inflation of transportation cost	3.13	10
11	Frequent moving of materials	3.12	11
12	Work repairing	3.10	12
13	Wrong ordering of materials	3.03	13
14	Poor material transportation arrangement	3.03	14
15	Poor shipping time	3.01	15
16	Poor policy in purchasing	3.01	16

Table 12 presents the rating of the respondents' perceptions on the materials management-related factors influencing Cost Variance/Overrun in Building Construction Projects. The result of the analysis shows that Inadequate storage facilities have the highest rating with a mean score of 3.69, next to it is damaged materials with a mean score of 3.65, followed by Loss of material with a mean score of 3.54, Inaccurate or poor estimation of the original cost with a mean score of 3.43, Pilfering of materials on-site with a mean score of 3.38, Overstocked materials with a mean score of 3.31, Under ordering of material with a mean score of 3.29, Poor handling of materials on sites with a mean score of 3.25 and poor policy in purchasing was rated as the least factor with a mean score of

3.01. Notably, all the factors have MSs > 3.00 , which suggests that all the factors have a major as opposed to a minor impact in terms of influencing Cost Variance/Overrun in Building Construction Projects. These findings agree with Abdul-Rahman et al. [13] and Veronika, et al. [16].

5. Conclusion

The study examined the degree of necessity and usage of material management methods adopted by small-scale construction firms in Abuja and Lagos State, identified and quantified the strength of the factors as it affects material management practices in the study area, and assessed material management-related factors influencing cost variance/overrun on building construction sites in the study area. The findings revealed that 74.1% of the small-scale construction firms executed projects for private individuals and organizations and have been in operations for more than ten years. Majority of the firms sampled (69%) make used of Gantt chart as their project planning technique, while 70% have executed more than ten construction projects in the last five years. The study found that 93.1% of Site supervisor/project managers were responsible for material management in the firms and that materials constitute over 40% of the total project cost. The study revealed five most important degree of necessity of material management methods as rated by the respondents as site planning and organization highest with a mean score of (4.95), employment of security measures on-site to safeguard materials with a mean score of (4.91), recording of usage and inventory of materials during construction with a mean score of (4.76) and preparing and monitoring of material schedules with mean scores of (4.69). However, the study found the most important degree of usage of the material management methods as Employment of security measures on-site to safeguard has the highest rating with a mean score of (4.88), recording of usage and inventory of material during construction with a mean score of (4.76), good supervision with a mean score of (4.14) and site planning and organization with a mean score of (4.09) while Site communication has the least rating on both the degree of necessity and usage with mean scores of (3.62) and (2.34) respectively.

The study revealed that the twenty-four factors identified to affect materials management practices were rated as severe by the respondents. The study found the most severe factors as poor site organization was rated the highest severe factor with severity index of (0.958), non-availability of material on sites with a severity index of (0.948), material not delivered as per schedule with a severity index of (0.928), non-standard specification with a severity index of (0.914), Non-availability of quantity required with a severity index of (0.910), Inadequate stacking and insufficient storage on-site with a severity index of (0.908), Using unsuitable places for storing materials with a severity index of (0.896). Material management-related factors found to influence cost variance/overrun of building projects were Inadequate storage facilities (3.69), damaged materials (3.65), Loss of material (3.54), Inaccurate or poor estimation of the original cost (3.43), Pilfering of materials on the site (3.38),

Overstocked materials (3.31).

Based on the above finding the following recommendations were made; proper site organization should be carried out on construction site; materials should be made available on-site with required quantities and delivered as at when due with adequate stacking and storage facilities. More so, there should be adequate storage facilities on construction sites, material damage/ loss of material should be reduced to the barest minimum. The service of a good estimator should be engaged by the firms to mitigate against inaccurate/poor estimation of materials.

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