

Evaluation of Material Management Practices in Building Project Delivery in the FCT Abuja, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author ML conceptualized designed and wrote the first draft of the manuscript. Author KCO performed the statistical analysis and managed the analyses of the study. Authors ML and KCO read and approved the final manuscript.

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ABSTRACT

Given the rising building collapses within the Federal Capital Territory (FCT), and the associated humanitarian consequences, this study evaluated materials management practices in building delivery process in build construction in Abuja, Nigeria. The study focused on analysis of material management practices, factors affecting effectiveness of material, measures for managing materials, usage of ICT (relevant software packages) in material management practices and the impacts of risk management plan on effective material management. The design for the study was descriptive survey. The sample was 476 respondents drawn from 1,950 Practicing Quantity Surveyors, Practicing Builders and Practicing Architects. Multi-Stage sampling which involved purposive, cluster and simple random sampling was employed to select the FCT, the zones, and the building professionals respectively. After analysis of data, the result indicated that planning, project drawing sections and material planning methods are the best material management practices observed by professionals in Abuja. Shortage of funds, excessive paper work, delay in material procurement, lack of material control, poor quality of material, damages of material and transport related problems were identified as problems militating effective material management. Findings further indicated that ICT usage had a positive and significant correlation with material management practices for effective building delivery process at $r(1, 408) = .593^*$, $p < .05$. It is recommended that regulatory bodies hold consistent sensitization on the best material management practices and enforce compliance from practicing professionals.

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1. INTRODUCTION

Building construction evolved as forms of shelter and protection from climatic and environmental factors which is central to human development as it provides the needed stability for human living and enterprise such as: setting up a home, offices for business, centers for recreation and interaction, places for religious activities, centers for treatments and hangouts for socializations etc. Building constructions are costly and require huge resources to erecting them [1,2].

The increasing cost of erecting building and delivering construction projects within the Capital territory is worrisome. The problem is a big barrier to the development of the Capital territory and has attracted the attention of the stakeholders on the causes of this rising cost profile in building delivery. There is concern among building management professional and civil engineering practitioners that the inherent dangers of poor management of materials for building construction delivery affect the quality of building construction delivery. Most constructions are poorly delivery with inadequate materials and technically know-how which is often caused by poor financing, purchasing, transportation and storage of building materials during project constructions. These have to large extent endangered lives and properties within the Abuja area. There is also the problem of quality of finished and delivered building constructions in Abuja area especially at the wake of many failed, dilapidated and collapsed building constructions in that area. The human cost usually associated with poorly delivered building and the cost of re-construction and managing it is usually unquantifiable. The challenges have both implications on building delivery and building management practice which has prompted a continuous search into its causes. This factor has made building construction a herculean task which has attracted the interest of professionals (e.g. builders, architects, civil engineers etc) in finding the most effective means of managing building construction. Consequently, in order successful erect or construct a building project, a number of issues arise as regard the material usage, labour and know-how [3]. These factors to a large extent are crucial factors as they determine the successful completion of any building project.

Materials management is a process that coordinates planning, assessing the requirement, sourcing, purchasing, transportation, storing and

controlling of materials, minimizing the wastage and optimizing the profitability by reducing cost of materials [4]. According to Husnain-Arshad and Jamaluddin [5], material management functions include; planning and material takeoff, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution. The result of improper handling and managing materials on site during a construction process influence the total project cost, time of project delivery and quality of projects delivered [6]. The goal of material management is to ensure that materials are available at their point of use when needed hence, efficient procurement of materials represents a key role in the successful completion of the work and project delivery. Therefore, there is a need for efficient materials management in order to control productivity and ensure smooth delivery with the right quality, function and optimum value. To achieve this, labour, materials and technology know-how have to be properly utilized and implemented.

Labour, materials and know-how remain the most critical factors in building construction with material management in the views of [7] considered very indispensable. The problems associated with material availability, material proneness to damage and substandard material; these unlike the other factors are best managed in accordance to proven procedures and human ingenuity. Thus, material management has become a topical issue in the delivery of building construction; one which is not easily neglected due to its overriding cost in the building construction as materials constitute a major cost component for any construction project. According to Akadiri [1], the total cost of installed materials (or value of materials) may be well over 60% of the total building construction cost. Given this implication, material management is as important as the building project itself; more so if the building construction should be timely delivered at minimal costs. In the light of the above, pertinent questions arise for building construction managers and professional construction engineers:

- i. What are the material management practices practiced by building engineers in FCT, Abuja?
- ii. What factors affect effectiveness of material management in building construction in FCT, Abuja?

- iii. What is the relationship between the usage of ICT (relevant software packages) in material management practices in building construction FCT, Abuja?

2. REVIEW

In developing cities such as Abuja in Nigeria, efficient and effective management of material is essential function for building construction success and project delivery [8], because it reduces projects' timeline for completion, saves cost and manpower engaged in building construction [9] and affects the quality and aesthetics of the finished building [8]. The problem of material management and lack of supervision and enforcement of building construction ethics and laws is one of the key issues facing construction sites in Abuja and Nigeria in general which can be traced to institutional corruption in Nigeria. [10] abusive supervision workers on the building site [11,10] poor innovative behaviour leading to worker frustration [12] and lack of trust and belief in ones profession or organizational tenets [13]. It is noted that the activities identified in the supply channel (the sourcing and transmission of purchase orders up to control of material wastages) are considered key to materials management because they primarily affect the economy, effectiveness of material movement, productivity, optimization of profit and reduction of material cost [9]. Material management is an important function in order to improve productivity and deliver projects within the stipulated time, budget and right quality.

According to Okolie et al. [9], the total cost of materials will include, in addition to the manufacturer selling cost, the cost of procurement (cost of placing, processing and paying the material, physical distribution, the distributor's cost, and the transportation of materials), and the site-handling costs (cost of receiving, storage, issuing, and disposal). The efficient procurement and handling of material represent a key role in the successful completion of the work. It is important for the contractor to consider that there may be significant difference in the date that the material was requested or date when the purchase order was made and the time at which the material will be delivered. These delays can occur if the contractor needs a large quantity of material that the supplier is not able to produce at that time or by any other factors beyond his control. The contractor should always consider procurement of materials as a potential cause for delay [14]. Poor planning and

control of materials, lack of materials when needed, poor identification of materials, re-handling and inadequate storage cause losses in labor productivity and overall delays that can indirectly increase total project costs. Effective management of materials can reduce these costs and contribute significantly to the success of the project. The major issue that adversely affects the performance of construction projects is the improper handling of materials during site activities. The inappropriate handling and management of materials on construction sites has the potential to severely hamper project performance [14]. There are major issues which affect materials management activities such as constraints on storage areas, site logistics with regards to materials handling and distribution, and also ordering and delivery of materials to the construction site.

Empirically, many studies have not considered the multifaceted nature of the problem and have only narrowed their approach in the search for the causes. For instance, [15] study on construction material waste management practices in selected construction sites in Abuja, Nigeria highlighted that poor management of building materials in projects are responsible for wastage. In as much as this is through, the study did show a direction on how the poor management of the materials affects the project delivery itself. Also, [1] study on the understanding barriers affecting the selection of sustainable materials in building projects only emphasized barriers affect the selection of sustainable materials in building projects without highlighting the consequences of the uses of such materials both the project delivery and the safety of the project. There is the problem of ascertaining how for instance material management impact and affect the building delivery and which type of impacts does it have and perhaps, practices which should adopted to enhance proper management. For instance, [14, 16] contended that the inappropriate handling and management of materials on building construction sites has the potential to severely hamper project performance.

Certain problems will be given consideration as regards the persistence of these building construction challenges. These problems border on: material requirements, vendor evaluation and purchasing while details of handling, storage and site distribution are left to be decided at the site; materials management systems practiced and ways and methods in which materials are planned, ordered, delivered and handled due to

the recognition of the costs associated with late ordering, wastages and poor handling facilities on construction sites in Abuja; professional such as contractors' losses in productivity resulting from insufficient material management which will eventually affect profit margin; risk factors and management of the outcomes in building constructions in Abuja area and institutional corruption [17] which have affected the supervision of building construction practices. The afore mentioned problems led to this investigation is suggestive that the current trend in building construction in Abuja is geared towards developing computer-based material data management system that provide the information needed to prevent material shortages, finding suitable vendors, surpluses and labor delays.

3. METHOD

3.1 Design

This study is survey study which adopted descriptive design approach (quantitative survey) in accordance with the research questions and hypotheses. Primary data was obtained by survey while secondary data obtained through review of extant literature.

3.2 Population

Population of the study was generally a large collection of civil related Quantity Surveyors, Builders and Architects.

3.3 Sample Size and Sampling Technique

The sample size of the study was 476 respondents selected from a population of 1,950 (Practicing Quantity Surveyors, Practicing Builders and Practicing Architects all in Abuja) sourced from their NIQS, NIB and NIA Abuja Branches. The sampling techniques for study was multi stage sampling for non probabilistic sample whereby purposive sampling was used to select the area (Abuja) while cluster sampling was used to select the three different locations in Abuja as clusters and simple random sampling was used to select each of the building professionals as participants in the study. Sample size determination was done using Yamane's sample reduction formulae [18] $n = \frac{N}{1+N(e)^2}$ when n = sample size, N = population, e^2 = Margin of error (assumed 5% or 0.05), 1 = unity or constant [19].

3.4 Method of Data Analysis

The research approach for this study involves quantitative method of data collection through survey and descriptive analysis. The method will make use of frequency, mean and standard deviation of the responses to analyze the data.

4. RESULTS

Table reveals 1 material management practices as observed by professionals was tested using research question 1 which presented the descriptive statistics on building construction practices companies use for managing materials in Abuja. Practices identified through the responses of the professionals is indicative that "Planning with engineering, construction and other project drawing sections" is the best material management practice observed by professionals with response mean of 4.4 which is followed by "Material planning methods" with mean response rate of 4.2. Also, the professionals indicated that "Recovering and recycling" and "Material handling" is also among the best material management practices observed by the professional at 4.0 and 4.1 mean response rate. However, the mean response of the professional showed that "early Purchasing of materials" is a rare practice with mean point of 2.67, so also is the "Transportation of the materials", "Ware housing management" and "Economic order quantity" with mean response rate of 3.5, 3.5, and 3.6 respectively. "Inventory management", "Material waste control" and "Just in time method is often practiced but they are not strong practices by professionals.

Equally, survey responses of building professionals on the critical factors affecting effectiveness of material management as observed by professionals reveal 14 most critical issues which critically affects the effectiveness of material management from a pool of 47 factors which affects material management practice in the area of the study. Topping the chart is the "shortage of funds" with mean score of 4.3. Other critical issues revealed which effect affects the effectiveness of material management are "Excessive paper work" at mean of 4.1, "Delay in material procurement" at mean of 4.2, "Lack of material control" at mean of 4.0, "Poor quality of material" at mean of 4.1, "Damages of material" at mean of 4.3, "Shortage of material in market" at mean of 4.0, "Site transportation difficulties" at mean of 4.3, "Damage during transportation" at mean of 4.0, "Site congestion" at mean of 4.1,

“Lack of material storage” at mean of 4.2, “Material storage far away from working area” at mean of 4.2, “Delays in material delivery” at mean of 4.2, and “Changes of material specification” at mean of 4.0. Although other factors highlighted remain a problem, participants’ mean responses which were below the theoretical mean point of the items were indicative that those factors are seldom occurrences and as such, have not reached critical situation in the area of the study. Respondents’ high mean point of the factors above is indicative that those factors are critical and affect the effectiveness of material management in the area of the study more than the other factors and thus could be adjudged critical.

From the Table 2, an observation is made that the usage of ICT (relevant software packages) in material management practices for effective building delivery processes is low. The mean

score of 2.8 on a 5 point likert scale is indicative that the average response rate of professionals is statistically low on technology usage (relevant software packages) in material management practices for effective building delivery processes, which the average response rate of 2.8 implies a “rare” technology usage (relevant software packages) and as such implies potential dangers for effective building delivery processes within the population. However, there is a relationship between technology (relevant software packages) and material management practices for effective building delivery processes. Professionals who used less technology (ICT) may not have a robust material management practice for effective building delivery processes. This relationship could be ascertained by correlating the responses of the participants on technology usage (relevant software packages) and the material management practices for effective building delivery processes.

Table 1. Descriptive statistics on building construction practices companies use for managing materials in Abuja

S/N	ITEM	Responses					N	\bar{X}	SD
		1	2	3	4	5			
1	Planning with engineering, construction and other project drawing sections	-	2 .5%	31 7.6%	155 38%	220 53.9%	408 100%	4.4	.7576
2	Purchasing of materials	98 24%	136 33.3%	77 18.9%	57 14%	40 9.8%	408 100%	2.5	2.6 70
3	Material planning methods	-	-	33 8.1%	242 59.3%	133 32.6%	408 100%	4.2	.58 96
4	Transportation of materials	-	90 22.1%	101 24.8%	114 27.9%	103 25.2%	408 100%	3.5	1.0 93
5	Material handling	-	-	133 27.7%	146 35.8%	149 36.5%	408 100%	4.0	.79 74
6	Inventory management	-	4 .9%	72 17.7%	270 66.2%	62 15.2%	408 100%	3.9	.59 95
7	Ware housing management	-	85 21.1%	101 24.8%	114 27.9%	103 25.2%	408 100%	3.5	1.0 93
8	Material waste control	-	2 .5%	107 26.2%	230 56.4%	69 16.9%	408 100%	3.8	.66 44
9	Economic order quantity	-	43 10.5%	135 33.1%	170 41.7%	60 14.7%	408 100%	3.6	.86 34
10	Just in time method	-	3 .7%	73 17.9%	270 66.2%	62 15.2%	408 100%	3.9	.59 95
11	Recovering and Recycling	-	-	129 31.6%	100 24.5%	179 43.9%	408 100%	4.1	.86 12

Table 2. Descriptive statistics for correlation of ICT usage with material management

	Mean	Std. Deviation	N
ICT Usage/Involvement	2.8	2.593	408
Material Management For Effective Building Delivery Process	3.9	.8351	408

From the correlation result in Table 3, it could be observed that ICT usage has a positive and significant correlation with material management practices for effective building delivery process at $r(1, 408) = .593^*$, $p < .05$. From the statistical finding the null hypothesis II which stated that technology usage (relevant software packages) have no impact in material management practices for effective building delivery process is rejected because the relationship is positive and significant which is indicative of linear directional relationship and hence impacts. The alternate hypothesis II which stated that ICT usage (relevant software packages) will impact material management practices for effective building delivery process is therefore confirmed. The impact implies that more professionals that used ICT in their building practices reported better material management practices for effective building delivery process. It could therefore be said that greater ICT usage and involvement of technology could positively enhance material management practices for effective building delivery process whereas lower ICT usage and involvement of technology in building process would affect material management practices for effective building delivery process negatively. Therefore, if professionals are more inclined in the ICT usage and involvement of technology in their building process there is a greater chance for better practice.

5. DISCUSSION

The study explored material management practices for effective building delivery process taking into account the extent of practices, its utility/prevalence and the relationship between the use ICT technologies in material management practice for effective building process in Abuja. Following from above, both local and international related literatures on material management practice for effective building delivery process were reviewed so as to conceptualization: of what constitutes material management in building delivery process in Abuja and other associated factors of interest.

After the analysis of data the result indicated the following findings planning, construction and other project drawing sections, material planning

methods, recovering and recycling and proper material handling were identified as the leading material management practices by professional in building construction companies in Abuja. Also, early purchasing of materials, transportation of materials, ware housing management and economic order quantity were identified as inconsistent material management practice by building professionals in Abuja whereas inventory management, material waste control and just in time method were neglected practices in material management practice by building professionals in Abuja.

As regards factors which affect the effectiveness of material management practices "shortage of funds", "Excessive paper work", "Delay in material procurement", "Lack of material control", "Poor quality of material", "Damages of material", "Shortage of material in market", "Site transportation difficulties", "Damage during transportation", "Site congestion", "Lack of material storage", "Material storage far away from working area", "Delays in material delivery" and "Changes of material specification" were identified.

Also, the study sought to ascertain the use of ICT in material management and the relationship between involvement of technology and effective material management practice for building delivery in Abuja. Data analyzed indicated that the use of technology in material management practice in building delivery is abysmally low whereas the significant positive correlation recorded between the two is an indication that use of technology influenced effective material management practice in building delivery in Abuja.

Measures for effective material management were explored and the result of the analysis reveal that there are measures practiced for material management with an overall mean point average greater than the norm for the mean of the total items weighted at 3.9. The finding confirmed that there are measures which could be employed for proper material management within the area of the study. The respondents gave significant supports to: training of personal staff in charge of materials management,

Table 3. Correlation between technology usage (relevant software packages) and measures for effective material management in building delivery process

		ICT Usage/ Involvement	Material Management For Effective Building Delivery Process
ICT Usage/ Involvement	Pearson Correlation	1	.593
	Sig. (2-tailed)		.006
	Sum of Squares and Cross -products	222.000	204.000
	Covariance	6.727	6.182
	N	408	408

inventory control of materials on site, ensuring proper planning, monitoring and control, timely placement of orders for materials and ensure coordinated quality assurance and quality control as some of the effective measures which could be applicable for effective material management practice in Nigeria.

The study also ascertained whether there is relationship between professionals' use of ICT/technologies (relevant software packages) and the material management practice for effective building delivery process in Abuja. From the findings, it was identified that although there is a bright promise in material management practice among building professionals in Abuja as indicated by participants' high score which is above the theoretical mean score of the scale used although, there were areas of material management practice which have poor management practice such as: complete quality records of materials, establishment of material management system, attention to weather conditions, record receipt of goods upon delivery, assigning material codes to the building materials, proper material handling keeping the store safe from theft and vandalism and submission of materials returned. These management areas remain a challenge to actualizing comprehensive material management practice in building delivery process by professionals in Abuja and thus leave room for improvement among building management professionals.

One of the critical components of material management practice in building delivery is proper material handling without which wastes and damage of building materials will become an unavoidable outcome. In the study area, building professionals seem not be entirely conversant with effective material management as regards handling. Their low mean score is indicative that their handling of the building materials is far from being effective in terms of cost and overall building performance. Considering that how the

materials are handled in the building delivery process has a primary and direct impact on the entire building outcome and it could be said that this poor handling also affected the safety of the materials as indicated in participants' means score showing that there is a poor practice of keeping the store safe from theft and vandalism.

6. CONCLUSION

This research highlighted the strength of material management practices by professionals in Abuja. Regarding the importance of material management in building delivery process the study sort to find out those material management practices that are being practiced by building professionals in Abuja. The study sought to find out if there are areas of weakness among the professionals in various aspects of material management in building delivery process. Although, the result indicated that majorly, most building professionals practicing in the study area adopted standard material management practice, however the result also indicated that a number of material management practice do not result in effective building delivery. The situation in view of its dangers is a wakeup call to stakeholders to double their vigilance on professionals who may insist on sharp practices or those who want to circumvent cost in the course of building delivery process.

7. RECOMMENDATIONS

Based on the findings of the research, the following recommendations were made:

1. Effective and efficient material management practice need to be taken seriously by stakeholders in building practice starting from the classrooms and the fieldwork because success of any building delivery process is dependent on that.
2. Particularly, there is need for stakeholders to sensitize professionals in the area of documentation and accounting for usage

and the nature of the materials delivered and used in the building delivery process. Many other problems related to material management in building delivery process may stem from this.

3. There is need for professionals in building delivery process to adapt their material in accordance to the nature of the environment and weather/climate conditions of the area.
4. There is need for supervisory professional bodies to monitor and oversee material management of builders on site and recommend appropriate sanctions to erring professionals in order to enforce and ensure that the best practices in terms of material management are enthroned and regulated for best result in protection of lives and properties. To actualize this there is need for an enforcement team on standardized material management practice whose responsibility will be to enforce compliance, apprehend offenders and prosecute same.
5. Non- financial penalties may be required such as withdrawal of license and certification in order to enforce compliance and also to serve as deterrent to other in the professionals in the industry.

CONTRIBUTION TO KNOWLEDGE

The gaps found in extant literature on project delivery have provided the current study the opportunity to contribute to the existing knowledge in the following dimensions:

1. Previous studies did not explore the impacts of Information and Communication Technology (ICT) on the project delivery in building construction in Nigeria particularly within the Abuja area. The current study showed that ICT influences effective material management which is an important part of building construction and which have effect on project delivery in building construction.
2. Also, previous studies did not focus on the risks and dangers associated with building construction which could also influence project delivery. This study also explored this as part of the objectives.
3. Material management practices as regards the use of materials, economic quantity, storage and transportation of materials to and fro the site and within site have been note as significant material management practices which are often neglected in most studies; however, in this study, their

effects were also explored and they have shown that they can influence project delivery in building construction. By studying their effects on project delivery in building construction this study has equally added to what is known.

FURTHER STUDIES

There is need to ascertain the nature of material management compliance in other regions of the country which will help national policy on building practice. There is also need to carry out a study on the relationship of material management and building delivery process between those with has robust material management practice and those with poor material management practice. There is also the need to ascertain if professional bodies and Nigerian Society of Engineers are doing enough to police the policy of effective material management and the areas of concern in the prosecution of offenders.

CONSENT

As per international standard or university standard, participant's written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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