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Impacts and Awareness of Materials Management Strategies on Project Delivery in Nigerian Construction Industry

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Abstract: Material management is the system for planning and controlling to ensure that the right quality and quantity of materials and equipment are specified in a timely manner. The research work evaluates the impacts and awareness of materials management strategies on project delivery in Nigerian construction industry. Seventy (70) questionnaires on construction sites will be chosen at random for the purpose of achieving the objectives of this impact and awareness of materials management strategies on project delivery in Nigeria construction industry were distributed for collection of data. Data were obtained from both the primary and secondary sources which include interview, questionnaire, textbooks journal publications and internet facilities. The result revealed that scheduling and planning ranked first with RSI value of 0.711(71.10%), planning and delivery ranked second with RSI value of 0.709 (70.90%), handling ranked third with RSI value of 0.674 (67.40%). These are followed by security systems, stock control, material variance analysis, waste control, inventory, Construction Materials Planning System (CMPS), Construction Materials Management Software (CMMS), ICT based material management techniques, Performance Information Procurement System (PIPS), Just-in-Time (JIT), Material Handling Equipment Selection Advisor (MHESA), Construction Materials Exchange (COME), and Enterprise Resource Planning (ERP) respectively. Conclusion and recommendations were made from the results obtained from the research.

Keywords: impacts, awareness, materials management, strategies, construction industry.

I. Introduction

The Nigerian building and construction industry continues to occupy an important position in the nation's economy even though it contributes less than the manufacturing or other service industries [1]. The contribution of the building and construction industry to national economic growth necessitates improved efficiency in the industry by means of cost effectiveness and timeliness and would certainly contribute to cost savings for the country. It is also common knowledge that the implementation of the construction project in the industry is usually accompanied with poor quality delivery and delivery time delay and cost increase as well as owner dissatisfaction [2]. Thus, the efficient use and management of material have an importance influence on a company's profit and can delay project construction [3].

Material management is the planning and controlling of all material and equipment, so they are requested in advance, obtained at a reasonable cost and are available when needed [4]. This definition includes not only materials that go directly into the product and the equipment to produce it, but also the spare parts needed for maintenance, in order to ensure uninterrupted operations [5].

Material management differ among organizations that is from the producers and users. In some businesses, the material handling process might include sourcing, procuring, transporting, storing and all other aspects of material flow. In other organizations, particularly large construction companies or manufacturers – separate departments might exist for procurement, supply chain, logistics and other functions.

Materials management functions include planning and taking off materials, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution [6]. Almost 60% of the total working capital of any industrial organisation consists of materials costs [7]. Materials management can only produce what it should with the right quantities of the right material at the right time [8]. Thus, any improper handling and managing of materials will cause a huge effect on the total project cost, time and quality

Direct materials are those that go directly into the product being sold, and therefore represent the cost and benefit of the product itself. These materials may include items such as wood, cement, pipes, glass, etc.

Availability and quality of direct materials are vital for project success. Poor planning for direct materials can cause significant losses and repercussions to the business and indirect materials are those that are part of the process, but do not go into the product itself. These materials may include items such as equipment and spare parts, staples for staple guns, drill bits, etc. Their value to the product cannot be easily quantified, but their absence or breakdown will negatively impact the process and results.

The importance of the material management process is often overlooked, but its poor execution will have severe, negative consequences. To appreciate this, it helps to understand the weight of a material manager's responsibilities. The material manager must ensure the right materials, in the right quantities, at the right time and place, from the right source and at the right price **[9].**

II. Literature Review

Material management can be defined as a process that coordinates planning, assessing the requirement, sourcing, purchasing, transporting, storing and controlling of materials, minimizing the wastage and optimizing the profitability by reducing cost of material. Building materials account for 60 to 70 percent of direct cost of a project or a facility, the remaining 30 to 40 percent being the labour cost [10].

Materials management is defined as a coordinating function responsible for planning and controlling materials flow [8]**.** In a detailed view, materials management is a planned procedure that comprises the purchasing, delivery, handling and minimisation of waste with the aim of ensuring that requirements are met [11]**.** Materials management is an essential function that improves productivity in construction projects. Hence, the efficient use and management of material have an important influence on a company's profit and can avoid delay in construction [12]. In order to better understand materials management which planning, procurement, logistics, handling, stock and waste control.

It is gathered that current manual materials management practices and control procedures are unsatisfactory as they are labour intensive, inaccurate and error prone. The implication leads to waste and surplus of materials, delays, decrease in productivity and lack of up to-date and real-time information [13]. Interestingly, many problems related to management surface amongst local contractors even in developing countries. The problems normally vary in nature and intensity but are usually related to the inefficient management of construction resources including materials, labour, plant and subcontractors [14].

Strategies of Materials Management

Material management is the system for planning and controlling to ensure that the right quality and quantity of materials and equipment are specified in a timely manner. Few main materials management strategies were being identified in the construction industry in Nigeria and are summarised as below:

Scheduling: Scheduling is the process of arranging, controlling and optimizing work and workloads in a production process or manufacturing process. The purpose of scheduling is to minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment.

Security systems: Construction Site Security Services. Security threats to construction sites include the loss of valuable machinery, workers possessions and even loss of life should trespassers disrupt areas of wiring or hazardous materials. Efficient security measures need to be considered in any construction site risk assessment.

Materials variance analysis: Materials variance analysis is the difference between the standard cost of direct materials specified for production and the actual cost of direct materials used in production

ICT based Material Management Techniques: Information Technology (IT) can be defined as the use of electronic machines and programmes for the processing, storage, transfer and presentation of information. Communication technology is today an important part of IT [8]. Together, they make up for the term ICT. Mobile devices range from Notebooks, personal digital assistants (PDA), portable data terminals (PDT), tablet personal computers to smart phones. Today, these devices have increased in style, functionality, capacity, application areas, features, usability, etc [15].

Performance Information Procurement System (PIPS): The performance information procurement system (PIPS) was developed at Arizona State University (ASU). It is used to delivered services. It minimises the client's risk/project management transactions by up to 90%, it can increase vendor profit up to 100% at no additional cost to the buyer, and delivers projects on time, no cost deviations, with high customer satisfaction at a 98% rate [16].

Just-In-Time (JIT): Just-in-time is an inventory management method in which goods are received from suppliers only as they are needed. The main objective of this method is to reduce inventory holding costs and increase inventory turnover [17].

Construction Materials Management Software (CMMS): Construction inventory, materials, equipment and tools tracking on the job sites using mobile application and QR code/barcode scanning. Real time reports via the web dashboard, accessible on demand from anywhere. Construction material management software which

reduces project cost by 10-15%. It enhanced processes for increased control and field productivity. Automate your construction procurement for a seamless purchasing experience. It encourages efficient procurement processes, cost and time saving

Construction Materials Planning System (CMPS): The construction materials planning system attempts to ensure that the right quality and quantity of materials are appropriately selected, purchased, delivered and handled on site in a timely manner and at a reasonable cost. Poor materials management can result in increased costs during construction [10].

Material Handling Equipment Selection Advisor (MHESA): Material handling equipment selection is an important function in the design of a material handling system, and thus a crucial step for facilities planning [18]. Proper material handling equipment can enhance the production process, provide effective utilization of manpower, increase production, and improve system flexibility. The importance of material handling equipment selection cannot be overlooked in determination of the best equipment alternative for a given production scenario is not an easy task [19]. Material handling accounts for 30-75% of the total cost of a product, and efficient material handling can be responsible for reducing the manufacturing system operations cost by 15-30% [20].

Construction Materials Exchange (COME): The construction materials exchange enables construction industries to save money on disposal costs and improve their green credentials by passing on for reuse any unwanted but usable building materials or other items from projects [21].

Enterprise Resource Planning (ERP): Enterprise resource planning is business management software that allows an organization to leverage a suite of integrated applications. Enterprise resource planning is used by organizations looking to manage their business functions within a centralized and integrated system. It stores all entered data into a single database, allowing all departments to work with the same information. Additionally, all this data can be organized, analysed and made into reports [22].

Planning: Materials planning in management is about what steps you need to take to reach the goal, what changes and hurdles to anticipate, and how to utilise human resources and opportunities to reach the expected outcome to include quantifying, ordering and scheduling. The materials planning process involves a careful analysis of the current resources and market trends and the prediction of emerging markets and future demand.

Procurement: In building construction, material procurement is the process by which the materials required to construct a building are selected, ordered, invoiced, paid for and delivered to the site [23]. Materials availability involves material schedule and proper coordination of the procured construction materials [24].

Logistics: Logistics is the process of planning and executing the efficient transportation and storage of construction materials from the point of origin to the point of use at site. The goal of logistics is to meet clients, consultants and contractors' requirements in a timely, cost-effective manner.

Handling: Construction material handling is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal. Materials handling equipment selection is an important function as it can enhance the production process, provide effective utilization of manpower, increase production and improve system flexibility **[14].**

Stock and waste control: It is an inventory control and the process and action required to manage raw materials, processed materials, maintenance and construction materials from its inception to its destination and disposal.

It is of great importance that the bulk of construction materials delivery requires proper management of stock control. Meanwhile, it is said that construction activities can generate an enormous amount of waste [25] and materials waste has been recognised as a major problem in the construction industry [26].However, tighter materials planning can reduce waste and can directly contribute to profit-improvement and productivity [27]. Each processes stated above plays an important role for an effective materials management. However, there are materials management issues that have not yet been tackled effectively. The following section will highlight on the current materials management problems faced in the construction industry.

Material management is a planned procedure that include, the purchasing, delivery, handling and minimization of waste with the aim of ensuring that requirement are met [11]**.** According to [28]**,** a detailed material schedule and co-ordination of the requisition and order of material are important in assuring material availability. Efficient material planning is a key to high productivity on site. Material planning embraces quantifying, ordering and scheduling-. Productivity will suffer if the material planning process is not executed properly [29].

[30] stated that another issue (which is sometime beyond management control) is material shortages, for example yearly cement shortages have long been a topic of debate within the construction industry. [6] investigated a total concept for a Material Management System (MMS), which combined and integrated the take-off, vendor evaluation, purchasing expediting, and warehousing and distribution functions of material. The system resulted in improved labour productivity, reduced material surplus, reduced material management, manpower and cost saving. [31] described a computer simulation model, which helps to solve the problem of

order and deliveries of materials in real life by keeping a predetermined list of order and delivery time of all the materials on site. The delivery of each kind of material then takes place automatically at the specified time.

Effect of Material Management

Failure as one of the effects of material management to achieve any of these the right materials, in the right quantities, at the right time and place, from the right source and at the right price has mention by [9] can result in operational disruptions, cost overruns and wasted materials, not to mention loss of profits, market share and professional reputation. Ineffective materials management for projects can result in significant cost blow-outs and delays in project completion. Such cost inefficiencies will negatively impact global competitiveness, and owner operators and engineering, procurement, and construction companies are trying to streamline work processes for their projects. Inaccurate materials information, such as incorrect bills of materials, inaccurate cycle counts, shipping errors, receiving errors and so on, will also affect the overall project life cycle and increase project costs. Having to deal with subcontractors outside of the materials management process impacts the overall project supply chain as there is an increased risk of data inconsistencies.

In order to better understand materials management, the following objectives of an effective materials plan fall are discussed: lower operating costs, optimal material selection, ideal inventory control [32].

Lower operating costs: Operational disruptions cause significant losses in profits, and material management errors can easily throw a wrench in the process. Conversely, an uninterrupted flow of materials lowers cost by helping to maximize productivity and efficiency. Material managers play a key role in controlling costs with their choices and control of both direct and indirect materials.

Optimal material selection: An experienced material manager will get the best price possible on high-quality materials to maximize profits. This involves keeping up with changing variables, such as material availability and price fluctuations, and adjusting the plan accordingly. Construction industries rely on material requisition of suitable, low-cost options without compromising quality or supply.

Ideal inventory control: Maintaining an ideal inventory is key to an effective material management plan. A savvy material manager minimizes storage requirements and waste, while ensuring direct and indirect materials are available when needed. This means establishing re-ordering plans and projecting inventory levels to hold for work in progress and remedial needs to avoid delay of time and wastage of construction materials [33].

III. Methodology

Seventy (70) questionnaires construction sites will be chosen at random for the purpose of achieving the objectives of this impact and awareness of materials management strategies on project delivery in Nigeria construction industrywere distributed for collection of data. Data were obtained from both the primary and secondary sources which include interview, questionnaire, textbooks journal publications and internet facilities. The data was analysed (i.e the mean and standard deviation), using statistical package for social society (SPSS). The statistical tools used for this study include percentage, mean, and relative significance index (RSI) to determine which of the impact and awareness of materials management strategies on project delivery in Nigeria construction industry. The relative significance index ranking (RSI) was used for ranking of the factors studied. These methods had been used in construction research by authors such as, [34, 35, 36, 37,38] among others. The Likert scale involving rating on interval scale of 5 and 1 developed for application in social sciences and management research for quantification of qualitative variable were used. It elicited information from the building construction professionals concerning the impact and awareness of materials management strategies on project delivery in Nigeria construction industry.

The responses of the items on the questionnaire were obtained on a 5-point scale ranging from 1 to 5. “Very High” were scored 5, ‘’High’’ were scored 4, ‘’Average’’ were scored 3, “Low” were scored 2 and “Very Low” were scored 1.

Relative Significance Index (RSI) is a non-parametric technique based on the aggregate weighting of the initial frequency score of factors. The Relative significance index was computed as

$$\boldsymbol{Relative\ Signicsnce\ Index} = \frac{\sum_{i=1}^{n=5} n_i k_i}{\sum jN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{\sum jN} \ (0 < Index < 1)$$

Where:

n_i = the number of respondents choosing

k_i = 1 -5 on the Likert scale.

$\sum N$ = the total of questionnaire collected (sample size).

j = the highest value in ranking order.

N = the total number of responses.

IV. Data Analysis and Results

The data were presented using tables for clarification and better interpretation. The analysis tools included both descriptive and inferential statistics.

A. Respondents Profile

Table 1: Sex

Sex	Frequency	Percentage
Male	51	72.86
Female	19	27.14
Total	70	100.00

Table 1 showed the gender of the respondents. It showed that 72.86 percent (51) are male, and 27.14 percent (19) are female. The result shows the representation of genders in the construction industry in the study area.

Table 2: Length of service

Years	Midpoint (x)	Frequency (f)	Fx	Percentage
1-5	6	16	96	10.62
6-10	8	13	104	11.13
11-15	13	12	156	16.43
16-20	18	14	252	27.31
above 21	21	15	315	34.51
Total		70	923	100

Mean = ∑fx/∑f= 923/70 = 13.19

Table 2 shows the respondents mean year of experience estimated at approximately thirteen years (13yrs). With this average working experience of thirteen years, respondents are deemed experienced enough to supply reliable data for the research .

Table 3: Professional qualification

Professional Qualification	Frequency	Percentage (%)
NIOB	34	48.57
NIQS	12	17.14
NIA	10	14.29
NSE	8	11.43
Others	6	8.57
Total	70	100

Table 3 represents the educational qualification obtained by the respondents. 48.57% is registered with NIOB, while 17.14% is registered with NIQS, 14.29% is registered with NIA, 11.43% with NSE and 8.57% with other professional bodies. The result shows that all respondents possess registration of their various professional bodies in Nigeria and for the adequate professional training to supply reliable data for the study.

Table 4: Awareness of materials management strategies in the construction industry

S/N	TECHNIQUES	1	2	3	4	5	TOTAL	TWV	RII	Rank
1	Scheduling	**12**	10	4	15	29	**70**	249	0.711	1
2	Security systems	**13**	**9**	10	19	19	**70**	232	0.662	4
3	Material variance analysis	**13**	**11**	8	24	14	**70**	**225**	0.643	**6**
4	Planning	**12**	11	5	11	31	**70**	248	0.709	**2**
5	Procurement	13	11	8	17	21	70	232	0.663	**4**
6	Handling	**11**	12	7	20	20	**70**	236	0.674	**3**
7	Delivery	**13**	10	6	13	28	**70**	248	0.709	2
8	Stock control	14	11	9	14	22	**70**	**229**	0.654	**5**
9	Waste control	13	**10**	14	17	16	**70**	**223**	0.637	**7**
10	Logistics	**11**	15	12	17	15	**70**	**220**	0.629	**9**
11	Inventory	14	**11**	10	19	16	**70**	**222**	0.634	**8**
12	ICT based material management techniques	12	18	10	18	12	**70**	**210**	0.600	**12**
13	PIPS (Performance Information Procurement System)	11	**17**	15	17	**10**	**70**	**208**	0.594	**13**

14	JIT (Just-in-Time)	**13**	14	17	15	11	**70**	**207**	0.591	**14**
15	CMMS (Construction Materials Management Software)	**12**	17	10	19	12	**70**	**212**	0.606	**11**
16	CMPS (Construction Materials Planning System)	11	**17**	10	19	13	**70**	**216**	0.617	**10**
17	MHESA (Material Handling Equipment Selection Advisor)	13	19	13	13	12	**70**	**202**	0.577	**15**
18	COME (Construction Materials Exchange)	12	18	15	17	8	70	**201**	0.574	16
19	ERP (Enterprise Resource Planning)	13	**15**	20	13	9	**70**	**200**	0.571	17

Table 4. showed the relative significance index (RSI) of the impacts and awareness of materials management strategies in the construction industry. The result revealed that scheduling and planning ranked first with RSI value of 0.711(71.10%), planning and delivery ranked second with RSI value of 0.709 (70.90%), handling ranked third with RSI value of 0.674 (67.40%). These are followed by security systems, stock control, material variance analysis, waste control, inventory, Construction Materials Planning System (CMPS), Construction Materials Management Software (CMMS), ICT based material management techniques, Performance Information Procurement System (PIPS), Just-in-Time (JIT),Material Handling Equipment Selection Advisor (MHESA), Construction Materials Exchange (COME), and Enterprise Resource Planning (ERP) respectively.

V. Conclusion

Nowadays, as in all construction industries, building processes and production are undergoing a digital transformation aimed at increasing productivity and profits, reducing waste and ensuring sustainability. The following conclusion were drawn:

- **i.** It improves productivity through proper control, tracking and monitoring of the system as needed.
- ii. It improves collaboration, awareness and accountability within the organization [22]**.**
- iii. There is a need of an efficient MIS integrating all aspects of material management through improved inventory monitoring.
- iv. Materials management strategies increase money saved and better analytics.
- v. It encouraged and improved production planning and resource management.
- vi. It makes the workers and customers to be happier and more comfortable.
- vii. Firms employing proper material management system are seen to have increased their overall efficiency by 35% [10].
- viii. There should be a simplified compliance and risk management among site workers and the organization.

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