

An Overview of Materials Management Control for Effective Project Delivery

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ABSTRACT

Materials management is the function responsible for the coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner in order to provide a pre decided service to the customer at a minimum cost. Effective and efficient management on site can enhance proper and overall construction project outcomes. Some measures like Effective requirement planning, Effective materials handling, adequate preparation materials document were introduced as a means of managing materials management in general. The cost of materials in a project represents a huge proportion of the cost of construction. Therefore, there is a need for efficient and effectiveness of materials management in order to control productivity and cost in construction projects. A survey was conducted and information collected from experts from different construction sites on the topic of discussion. Responses were analyzed in other to consolidate on the premise of material management control. Chi-square and mean score using the weighted average formula and ranking were used to analyze the data collected, thus embracing the objectives of the study. Findings revealed that the major factors responsible for poor material management are Lack of establish quantities of materials before orders are made, with mean value of 3.54; Lack of consideration in detail the period over which deliveries can be spread without affecting the contract, with mean value of 3.54; Delay in receiving materials on sites, with mean value of 3.48; etc. The impact of these factors includes; systematic operation, reduction in cost of material handling, reduction in overall cost of the project, etc.

However, this study recommended a centralized material management team and proper coordination between the site and the organization, Proper control, tracking and monitoring of the system, adequate awareness and accountability should be created within the organization, etc. to the project managers for effective and efficient control and management of materials in projects.

Keywords: material, management, control, project, delivery.

INTRODUCTION

The Wikipedia dictionary defined Materials management as the function responsible for the coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner in order to provide a pre decided service to the customer at a minimum cost. In construction project, the availability of materials in the right place at the right time coupled with having a right person with right skills and equipment that are able to deliver on time and on budget is very crucial. Previous studies in building sector have indicated that building materials account for between 50 to 60% of the total construction input [1]; [2] yet adequate attention has not be given to materials

management in general. Materials is generally measured by accomplishing on time delivery to the customer, on time delivery from the supply base, attaining a freight, budget, inventory shrink management, and inventory accuracy. Effective and efficient management on site can enhance proper and overall construction project outcomes. Management is an act of planning, implementation and controlling of construction resources in terms of supply, storage, processing and handling [3]. The result of improper, handling and managing materials on site during a construction process will influence the total project cost, time and the quality [4] Proper planning

becomes the basic and essential guide to construction teams and other management devices of controlling materials have to start from designing stage in order to optimize profit, reduce cost and quality. Besides, the cost of materials in a project represents a huge proportion of the cost of construction. Therefore, there is a need for efficient and effectiveness of materials management in order to control productivity and cost in construction projects. A good managed material in construction project will be of benefit to the industry because it encompasses different dimensions loopholes such as pilfering, deterioration during storage, delays and extra expenses may be incurred if materials required for activities are not

available. [5] states that material may deteriorate during storage or be stolen; also delay and extra expense may be incurred if material required for particular activities are not available. Prior to that, poor handling of construction materials affect the overall performance of construction projects in terms of quality, time, cost and productivity. The excessive waste of materials during construction can also be avoided in order to reduce loss of profit on construction target/cost. Based on the scenario above, the paper provide a better understanding on the concept of materials management and its related components in Nigeria using Enugu as it scope of the study.

LITERATURE REVIEW

[6] indicated that almost 60% of the total working capital of any industrial organization consists of materials costs. However, [7] observed that a good proper material management in the project delivery will bring reduction in construction costs, improvement in productivity, quality and timely on project delivery. Material management effectiveness must be a major concern on project delivery. Therefore, there is need for efficient materials management and a good supply chain in order to control productivity and cost in construction projects. There are many issues which contribute to poor materials management in construction projects. [8] suggested that waste, transport difficulties, improper handling on site, misuse of the specification, lack of a proper work plan, inappropriate materials delivery and excessive paperwork all adversely affect materials management. [9] divided material management into five categories namely, measurement and specification, procurement and purchasing process where the order is transmitted to the supplier, delivery to site and logistics of checking the order, off-loading, and storing on site, administrative and financial process of payment and using the materials in production on the job site and removing the waste.

[10] define materials as the goods purchased from sources out of the organization that are used to produce finished products. [11] informed that the construction materials can be classified into different categories depending on their fabrication and in the way that they can handled on site and these include:

Bulk materials: These are materials that are delivered in mass and are deposited in a container.

Bagged materials: These are materials delivered in bags for ease handling and controlled use.

Palletted material: These are bagged materials that are placed in pallets for delivery.

Packaged material: These are materials that are packaged together to prevent damage during transportation and deterioration when they are stored

Loose materials: These are materials that are partially fabricated and that should be handled individually.

Building materials have an important role to play in this modern age of technology, although their most important use is in construction activities, no field of engineering is conceivable without their use and also, the building materials industry is an important contributor in our national economy as its output governs both the rate and the quality of construction work.

Building materials are bought in standard length or lot quantities. Examples of such materials include pipes, wiring, and cables.

The use of materials on construction site

Engineered materials are specifically fabricated for a particular project or are manufactured to an industry specification in a shop away from the site. This includes materials that require detailed engineering data while fabricated materials are materials that are assembled together to form a finished part or a more complicated part. Examples of such materials include steel beams with holes and beam seats. Other material includes cement, blocks/bricks, reinforcement bars and glass products.

Materials Management and Its Processes

Materials management is a process that coordinates planning, assessing the requirement, sourcing, purchasing, transportation, storing and controlling of materials, minimizing the wastages and optimizing the profitability by reducing cost of materials [12]. The essence of this coordination is to optimize cost, ensure quality and availability of sufficient quantities of material for project needs. A construction project that has a good and effective materials management tends to maintain these processes in order to be successful and researcher itemizing six processes that can lead to its goal.

Material Planning

The most essential guide for project planning is Bill of Quantities prepared by the client's Quantity Surveyor, it will enhance good planning and control toward meet the required date, at optimum cost with desired quality. According to [13] informed that the most commonly used basis for planning things out for the project is the Bill of Quantity prepared by the client. Material planning helps in providing co-ordination within the project team and engineers in the project delivery in terms of uses of firm's resources.

Assessing of material

This process is able to identify the materials needed, including its specifications and calculate the required quantity of project materials. Obviously, the uses of drawing and specification in deriving out quotation helps the builder estimate in controlling, managing and directing the work. This is done in order to achieve the total actual required quantity of materials needed at a particular time. This will evaluation will enable them to classify

the materials according to their operational stages and costs for consistency based on their specification and schedules.

Procurement

Procurement is not only about appointing contractors and preparing contract, but is also very much a starting point in the process of delivery [14]. Therefore to successfully deliver a project it is not about adopting a procurement system with best practice tactic to fix all problems, but to embrace an approach that has the best-fit tactic that gets the job done most efficiently [15]. Procurement is a wide term which covers all the firms purchasing and related activities. Activities included in the procurement process range from purchasing of equipment, materials, labour and services required for construction and implementation of a project [16].

Purchasing

Purchasing has the responsibility and authority to commit projects for materials through an appropriate vendor [17]. Purchasing involves obtaining all materials, tools and supplies necessary for operation and maintenance of the organization's facilities; it includes the responsibility of obtaining the right quality at the right prices, from the right source and at the right time to ensure the availability of material in the construction sites. Purchasing function is primary necessity to materials management.

Transportation of materials

The movement of materials, equipment, and personnel to the job site thereby encompasses planning and controlling flow in order to represents a unique and specialization element of materials management. Experienced traffic personnel can have a positive impact on the execution of the project while minimizing transportation cost [18]. Good logistics involved the use of minimum of materials waste on site, having a good cash flow; this makes it easier to keep the site clean and tidy for an effective logistics team. Transportation will also pay attention to the maintenance of plant and equipment. Transportation aids the materials management team in handling numerous types of special loads from delicate electronics to massive modules. Knowledge of requirements, source and availability of

this equipment may be critical to successful execution of the work, transport permitting requirements also must be considered early in the project [19]. For smoothly handling the materials, space need to be carefully allocated for material handling equipment, access roads, warehouses, workshop, and laydown materials in the construction site [20]. ECI (1994) states that material delivery to site is a critical productivity-related aspect which demands the introduction of a carefully-developed system of monitoring and control as early as possible and transportation in terms of loading and off-loading of materials should not done in rainy season to avoid damages and wastes

Materials Storage and Control

Effective material handling involves handling, storing and controlling of construction material [21]. Material storage on site requires close attention in order to desist from waste, loss and any damage of materials which would affect the operation of the construction project. Problems always arise during materials supply because of improper storage and protection facilities [3]. Material storing on site can sometime have some negative impact on project outcomes if it is not properly attend to. Material can be damaged by weather, moving equipment's or people Fei, (2014). When proper protection during storage is ignored, this can result to poor material quality or material deterioration. Stock control can include raw materials, processed materials, and components for assembly, consumable stores, general stores, maintenance materials and spares, work in progress and finished products. A material control is of a great importance to the project delivery on construction management. This function is important to avoid any potential materials shortage or surplus occurring at the construction sites. The efficiency of this measure is to optimize the construction productivity and minimizes the construction costs. It is also noted that the storage area needs to be clean, enclosed and dry with good circulation and for some materials need to be stacked on pallets, not more than a certain safe height to prevent dampness and so on (Low & Ong, 2014). By adopting this effective measures for material storage

and control will help to keep the material intact and in good quality. And also will reduce loss of profit due to theft, damage and wastage as well as running out of stock as asserted [4]

Impact of Materials Management in Project Delivery

A construction project depends upon having the right people with right skills and equipment that are able to deliver the project on time and on budget. From the related literature studied above, material management can help in proper project delivery. Effective use of 4mens in the construction site will harmonize a great impact to the material management. They are as follows.

- i. Systematic operations
- ii. Reduction in cost of material handling
- iii. Reduction in overall cost of the project
- iv. Increase in productivity of the labors
- v. Time management
- vi. Quality control
- vii. Better relations with suppliers
- viii. Better relations with customers.

Innovative Trends on Material Management

They are some measures which are introduced as a means of managing materials management in general.

- i. Effective requirement planning: it is important for projectsto plan properly with enough details before involving in the main project i.e. construction aspect. Since a project involves different stages, manages different people, machineries, enough capital and so on, these becomes a reason why a lengthy time has to be spent during pre-project phase on design stage in order frequency monitoring on the drawings, schedules and specifications and ensure quality control of materials.
- ii. Effective materials handling: Tompkins and White (1984) defined effective material handling as using the right method, amount, material, place, time, sequence, position, condition, and cost. This involves handling, storing, and controlling of

the construction materials. Handling of materials is the flow component that provides for their movement and placement. The importance of appropriate handling of materials is highlighted by the fact that they are expensive and engage critical decisions.

- iii. Adequate preparation materials document: Appropriate preparation of materials schedules, material specifications and network analysis from the inception of project will reduce improper control of material wastages. A good material schedules provide benefit to the teams operation and provide coding and classification of materials.
- iv. Use of IT: Use of IT has the capability for changing a cultural structure with an objective by reducing barriers between different functionality. IT also is a great opportunity for communication between different parties and

different activities. Electronic data interchange (EDI) and Electronic funds transfer (EFT) are some other technologies in IT that enable a retailer to electronically do some functionality such as purchasing orders, paying invoices and processing credit checks. SMEs want to use affordable, reliable, and available technologies to improve performance that are straightforward to use. One such technology is Bluetooth, which is an open wireless. Such basic technology like mobile telephony or laptop is the most common available at the moment. Some other technologies such as internet, RFID (radio frequency identification), GIS (geographic information system), GPS (global positioning system), tracking technology are available in which have the capability of tracking materials

RESEARCH METHODOLOGY

To achieve the aim of this study, a survey was conducted and data collected from experts from different construction sites managed by four (4) different construction companies on the impact of material management and that was conducted in Enugu town comprising of six major construction companies and professionals in the building industry.

A total of one hundred (100) of the questionnaires were constructed and distributed out of which eighty (80) representing 60.0% were properly completed and returned. Relevant secondary data obtained from related text books, journals and book of proceedings were used while interviews and questionnaires were used for primary data collection in this research work. Meanwhile,

chi-square and mean score using the weighted average formula and ranking were used to analyze the data collected, thus embracing the objectives of the study.

A total of hundred questionnaires were launched to five building sites from Enugu state and expert opinions were collected from professionals in the building industry in the same area. Each respondent was asked to rate the identified challenges factors responsible for poor materials management on a likert scale 1 to 5. Where 1 = very little effect; 2 = little effect; 3 = fairly; 4 = severe effect; and 5 = very severe effect. Finally eighty seven questionnaires were properly completed and returned as shown in Table 1. In order to rank the severity of the factors, a Mean Score index was employed.

DATA ANALYSIS PROCEDURE

Most of the questions in the questionnaire relied on the review of related literature assessing some indices on materials management in effective project delivery. The data analysis thereby employs the following:

- a. Computation of the mean using the weighted average formula

$$\bar{X} = \frac{\sum fx}{\sum f}$$

Where \bar{X} = mean

X = Points on the likert's scale (5,4,3, 2 and 1)

F = Frequency of respondents.

RESEARCH FINDINGS AND DISCUSSION

Data obtained from expert opinion survey are presented in tables 1

Table 1: Response on Factors Responsible For Poor Material Management

S/N	FACTORS	RANK SCORE					TOTAL	MEAN SCORE	MEAN RANK
		VLE	LE	F	SE	VSE			
1	Lacks of established quantities of materials before orders are made.	11	9	16	27	24	81	3.54	1
2	Lack of consideration in detail the period over which deliveries can be spread without affecting the contract.	10	11	22	17	27	87	3.54	1
3	Delay in receiving materials on sites.	13	12	15	16	31	87	3.48	3
4	Poor control of materials wastage on site	13	8	18	24	24	87	3.45	4
5	Lack of consideration of making deliveries of materials at scheduled dates and time.	10	15	17	21	24	87	3.40	5
6	Lack of keeping adequate buffer stock in case of delay in receiving materials.	16	12	16	19	24	87	3.26	6
7	Non consideration of stocking materials at various points where work is going	17	14	20	20	16	87	3.06	7
8	Inadequate protection of materials which can cause problems of (workmanship and general finish).	17	16	21	14	19	87	3.02	8
9	Lack of planning of sites to indicate main storage area and stockpiles	18	16	16	19	17	87	3.03	9
10	Lack of procedures for checking inspecting and documentation of materials.	17	18	15	20	17	87	3.01	10
11	Lack of co-ordination for movement of plant handling materials.	20	18	17	15	17	87	2.93	11
12.	Lack of co-ordinate system of withdrawing materials from the stores.	20	18	17	15	1	87	2.90	12
13	Double handling of materials (which can cause problems of workmanship and finish	20	17	19	16	15	87	2.87	13
14	Lack of proper design (which do not allow effective handling and fixing of materials.	23	18	15	15	16	87	2.80	14
15	Lack of pre information toward the arrival of the goods.	21	19	16	15	16	87	2.71	15

From Table 1, lack of establishment of approximate quantities of materials before order are made and lack of consideration in detail the period over which deliveries can be spread without affecting the contract was observed to be the most 1st important challenges factor affecting materials management in the project delivery scoring mean score (3.5) respectively, they are called material schedule. From the study, preparation of material schedule is given high priority despite, it the estimator who produces schedules and figures of material to the buyer. According to [5] informed that the most commonly used basis for planning things out for the project is the Bill of Quantity prepared by the client. Consequently, the presentation and clarity of the schedule does not always receive sufficiency as a material control document. For the benefit of materials management,

material schedule in the bill should be most important document associated with project programme in order to manage materials effectively. Proper schedule of ordering of materials has to be confirmed by the site manager based on dates and time of arrival in order not to have adverse effect on contract. Material can be damaged by weather, moving equipment's or people [13], When proper information and protection during storage is ignored, this can result to poor material quality or material deterioration Nevertheless, other challenges such as overestimating the quantity required, faulty workmanship, misinterpretation of drawings, careless handling of materials, and design requirements such as excessive cutting of components to achieve non-standard solutions can be control once material schedule has been put in place.

TABLE 2: Responses on the Impacts of the Factors on Materials Management (Using Chi-Square etc. to Analysis). It shows the data gathered for the impacts of materials management effectiveness from different construction firms in Enugu using chi-square for its analyzing. They are as follows.

S/N	IMPACTS	O	E	(O-E)	(O- E) ² /E
1	Systematic operations	11	7.6	21.16	2.78
2	Reduction in cost of material handling	7	7.6	21.16	2.78
3	Reduction overall cost of the project	4	7.6	11.56	1.52
4	Increase in productivity of the labors	3	7.6	70.56	9.29
5	Time Management	14	7.6	40.96	5.39
6	Quality Control	16	7.6	21.16	2.78
7	Better Relations with supplier	3	7.6	12.96	1.71
8	Better Relation with customers	3	7.6	0.36	0.05

Source; Field Survey (February, 2020)

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where O= Observed,
E= Expected

CONCLUSION

Materials management control is as old as the construction industry. It is a practice which contributes mostly on time, quality and cost. Since the study have tried to address the issue towards the challenges, I believed that the professionals should put more interest on the identified

measures by contacting the quantity surveyors and cost engineers in the project delivery in order to upgrade their standard in those affected areas , their preparation of schedules could be classified into groups or operational stages and should start from pre-contract stage -contract stage -

post -contract stage in order to ascertain a clear maintaining flow and supply of materials accordingly. Finally, a good site controller should be able to address these functions especially in the area of establishment of quantities of materials in

time before arrival in order to have a pre- information and protection toward those materials, avoid waste in the site and to embrace the impacts of materials management.

RECOMMENDATIONS

Based on the research analysis and findings, the following recommendations are stated:-

1. There should be a centralized material management team and proper co-ordination between the site and the organization.
2. There should be a Proper control, tracking and monitoring of the system.
3. Adequate awareness and accountability should be created within the organization
4. There is a need of an efficient MIS integrating all aspects of material management.
5. Use of software like MSP, PRIMAVERA, ERP, SAP, etc. should be done to avoid manual errors in material management.
6. To avoid delay due to rejection of materials by quality control department or seasonal problems, the construction firms should store extra materials like steel, cement, etc. for emergency purpose.

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