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# Inventory Management and Construction Project Delivery in Nigeria

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**Abstract.** Effective management of inventories has been widely acclaimed as an important panacea for sustainable construction project delivery. This paper evaluates inventory management practices in the Nigerian construction industry. To achieve this, the specific objectives are to; (1) assess inventory management practices in the construction industry and (2) explore the influence of inventory management on project delivery in Nigeria. A structured questionnaire was distributed to 110 construction companies in three strategic cities of Lagos, Abuja and Port Harcourt using purposive and stratified sampling techniques. Ninety (90) valid responses were retrieved giving a response rate of 82%. Data collected were analysed using descriptive and inferential statistics. Findings reveal that materials requirement planning (MRP) with a mean score of 3.972 was the top ranked technique for construction project management in the Nigeria. This is closely followed by warehousing management (WM) (3.961) at the second, first in first out (FIFO) (3.880) at the third, Findings also reveal that the level of use of all the three inventory management techniques had significant influence on project delivery time and cost but not on quality. The paper recommends that contractors and industry associations should embrace the concept of inventory management to improve efficiency in terms of growth, turnover and sustainability. Besides, stakeholders should carry out advocacy and sensitisation to improve level of awareness while educational construction institutions should update their curriculum to incorporate sustainable and more innovative technologies into inventory management.

**Keywords:** Materials management, Project performance, Construction industry, Nigeria

## 1 Introduction

Inventory management has been described as a very critical management technique used by companies to manage inventories [1]. It is defined by [2] as a framework employed in firms for controlling its interest in inventory. It includes the recording and observing of stock level, estimating future request and settling on when and how to arrange for more inventories. In the construction industry, construction materials which are the major inventories constitute the major cost component in any construction project. The cost of these materials may be 50% to 70% of the total construction cost [3] which goes to indicate that consequence of mismanagement of these materials could be very colossal. Ineffective management of inventories result in either of two scenarios. Too much stock could result in funds being tied down, increase in landing cost, deterioration of materials in the storehouse, obsolescence and theft. However, shortage of materials could lead to interruption of supplies; disruption of construction

programme and ultimately increase in cost overrun. According to [4], material management is classified into five categories namely, (1) measurement and specification, (2) procurement and purchasing process where the order is transmitted to the supplier, (3) delivery to site and logistics of checking the order, (4) offloading, and storing on site, and (5) administrative and financial process of payment. Proponents of inventory management also called materials management had argued that it maintains adequate control of demand and supply of materials, it ensures 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, while there is reduced liabilities and loss on account of overstock.

In operations management research, the concept of inventory management has been extensively explored; inventory management practices ([5]; [6]; [7]; [8]); relationship between inventory management and performance ([9]; [10]; [1]). For instance, [1] observed that there is a strong relationship between four constructs of inventory system and performance of procurement option for sugar manufacturing industry in Kenya. Additionally, [11] analysed inventory management practices and observed that ABC is one of the most conventionally approaches used in India. Besides, improper handling and storage of construction materials on the site has made it difficult to effectively track construction materials. In Nigeria, [12] recently assessed the impact of logistics factors on material procurement for construction projects and observed that vendor qualities and competence of procurement officer were the most critical factors for effective materials management for construction projects in Abuja, Nigeria. [13], however established planning and handling as critical to effective material management of constriction projects in Nigeria. Although these and several other previous studies have provided insight into the concept of inventory management, many of these studies have concentrated on sectors other than the construction industry on one hand and on the experiences of countries in Europe, Asia and USA on the other. Besides, the relationship between inventory management and project performance has been largely ignored as most studies have concentrated on relationship between inventory management and firm performance. This study fills the knowledge gap by employing more robust statistical tools applied to a recent sample of construction companies in the oil rich Niger Delta region of Nigeria.

Given the background above, the aim of this paper is to evaluate inventory management practices in the construction industry with a view to improving project delivery in the Nigerian construction industry. The specific objectives are to: (1) assess inventory management practices in the construction industry and (2) explore the influence of inventory management on project delivery.

# 2 Literature Review

## 2.1 Inventory management

Inventory management is the process of managing inventories with a view towards meeting the expectations of clients at the lowest possible disruptions and cost. In other words, it includes all activities of planning, forecasting and replenishment of stocks to minimise differences between customers demand and availability of items. The central

theme is management of materials. [4] observed that common problems associated with material management on construction site includes; failure to order on time which delays the projects, delivery at the wrong time which interrupts the work schedule, over ordering, wrong materials or error in direction of materials requiring re-work, theft of materials from delivery into production and double handling of materials. However, materials management systems are effective for fast-track projects delivery which is why there is need for an integrated material handling process from the design stage to the usage of materials on sites [3].

## 2.2 Inventory management techniques

Literature has established inventory management as a veritable tool for sustainable project delivery in the construction industry apparently because it guarantees balanced items of stock are sustained at the right quality, quantity and that are obtainable at the right time and in the right place [13]. Some of the techniques used in managing inventories are discussed below:

### *2.2.1 Material requirements planning (MRP)*

Material Requirements Planning (MRP) is a computer-based production planning and inventory control system and is concerned with both production scheduling and inventory control [15]. It is a material control system that attempts to keep adequate inventory levels to ensure that required materials are available when needed. It is applicable in situations of multiple items with complex bills of materials. It is however not useful for activities for which continuous processes that are tightly connected. According to [15], the major objectives of an MRP system are to: ensure the availability of materials, components, and products for planned production and for customer delivery; maintain the lowest possible level of inventory; and plan manufacturing activities, delivery schedules, and purchasing activities. In the construction industry, MRP include all strategies, tactics, and tools for managing the design and construction delivery processes and for controlling key factor to ensure the client receives a facility that matches their expectations and function as it is intended to function [16].

### *2.2.2 Always Better Control (ABC)*

ABC is an inventory management tool in which materials are grouped into three categories depending on their perceived values. The first group known as “A” group comprises costly items that are 10 to 20% of total items in a store but account for 50% of total cost of all items. The second group known as “B” group comprises materials 20 to 30% of total stock but accounts for only 30% of total value of stock in the store. The third or “Q” group has 70 to 80% of total stock but accounts for only 20% of total value. This technique assigns items to three groups according to the relative impact or values of the items that makes up the group. Those thought to have the greatest impact, or value, for example, constituted the ‘A’ group, while those items thought to have a lesser impact or value were contained in the ‘B ‘ and ‘Q’ groups respectively [17]. It is a tool that among others, ensures considerable reduction in the storage expenses.

However, the technique can only be successfully deployed if there is proper standardisation of materials in the store. This is particularly challenging in the construction industry of developing countries such as Nigeria where infrastructure deficit challenge has tendered to hamper automation in construction methodologies.

### *2.2.3 Economic order quantity (EOQ)*

According to [18], EOQ is an inventory management tool used to ascertain the amount of orders that will minimise total variable costs required to order and hold inventory. In other words, it refers to the order sizing that will result in the lowest total of ordering and carrying costs for an item of inventory. The economic order-quantity model considers the trade-off between ordering cost and storage cost in choosing the quantity to use in replenishing item inventories. A larger order-quantity reduces ordering frequency, and, hence ordering cost/ month, but requires holding a larger average inventory, which increases storage (holding) cost/month. On the other hand, a smaller order-quantity reduces average inventory but requires more frequent ordering and higher ordering cost/month. One of the most important problems faced by the purchasing department is how much to order at a time. Purchasing in large quantities involve lesser purchasing cost. But cost of carrying them tends to be higher. On the other hand, if purchases are made in smaller quantities, holding costs are lower while purchasing costs tend to be higher. This can be rectified with the help of EOQ.

### *2.2.4 Just-In-Time System (JIT)*

JIT is an approach in inventory management that helps to make rational and appropriate order of materials available to each operating unit at the right time in the right quantity [19]. It is a systematic concept consisting of JIT purchasing, JIT transportation and JIT production. These three elements combine to create a material handling system that avoids waste and minimises inventory investment. The technique has changed employees' belief, attitude, work habits and awareness of quality assurance. One of the strengths inherent in JIT is the fact that it makes production operations by manufacturers more efficient, cost effective and customer responsive. Thus, components and parts are proactively acquired before they are needed in the assembly line, thereby relieving manufacturers of the cost and burden associated with housing and managing idle parts. According to [20], the philosophy behind JIT has a lot of potentials for managing movement of construction materials from manufacturing yard to construction site.

Several other techniques are found in the literature. These include purchasing of materials [21], transporting of materials [22], and materials handling [23]. Others are warehousing management ([24]; [25]), vendor managed inventory [26]. Researchers are unanimous that these are variates of inventory management systems. This study explores their extent of use in the Nigerian construction industry.

### *2.2.5 Inventory management and project performance.*

Researchers such as [27] and [9] have opined that inventory management which has been characterised by transaction approach techniques such as EOQ and management oriented concepts such as JIT and MRP have effect on firm performance despite their perceived theoretical and practical shortcomings. [9], had observed that the higher the level of inventories persevered by a firm, the lower its rate of returns. In other words, the hypothetical assumption that efficient inventory management leads to improvement in financial performance was rejected by the study, although it has a limitation that the study was conducted in only chemicals sector of Greek manufacturing industry. In another study, [1] discovered that four variables of inventory management (lean inventory systems, strategic supplier partnerships, information technology, and legal policies) have strong relationship which procurement function in a sugar manufacturing firm in Kenya. [28], discovered that inventory control management by way of easy storage and retrieval of material, improved sales effectiveness and reduced operational cost. [29], observed that inventory control significantly influenced productivity and concluded that inventory management is essential in the operation of any business. [30], carried out an investigation on impact of inventory management on performance of Malaysian construction firms. The study concluded that there is correlation between inventory delays and company performance operationalised as return on assets and return on investment.

While these studies gave clear insights into relationships between inventory management and performance, few gaps exist which this study intends to fill. Most of the studies were based on sectors other than the construction industry while virtually all concerned carried to investigate performance of firms leaving out project performance. This study investigates the nature of relationship between inventory management strategies as independent variables and project performance as dependent variable.

## 3 Research Methods

To investigate inventory management practice and its influence on project delivery, taxonomy of variables was extracted from the literature review in the relevant domains. A pilot study was conducted through interview with academic and industry experts to improve the taxonomy prepared from the literature review. The final list of variables was chosen under two key constructs of inventory management techniques and project performance to reflect the theme of the research problem.

In line with quantitative survey adopted for the study, a self-completion questionnaire was sent to 110 construction companies drawn from the register of the Federation of Construction Industry (FCI), Nigeria, and who are domiciled in three strategic cities of Lagos, Abuja and Port Harcourt in Nigeria for the study were collected through a structure questionnaire. The questionnaire was divided into four parts. Section A captured the respondents' demographic data (job description, educational qualification, and location etc.), section B solicited responses on inventory management techniques in use in the area, while section C was on influence of inventory management on 3 key project management variables of "timely delivery of materials", "reduced project cost" and "quality of completed projects". Target respondents were mainly project managers, purchasing officers and procurement

officers who conversant with on-going projects of their companies. Data collected were analysed using basic descriptive tools and Spearman rank correlation.

# 4 Results

## 4.1 Sample characteristics

Majority of respondents were from Lagos (44%) while in terms of job description, they were almost evenly spread across the four groups used for the survey. For instance, 23% were project managers, 31% were purchasing managers, 32% were procurement officers, while store officers comprised 14% as indicated. In terms of years of experience, more than 50% of respondents have spent 10 years and above in their present positions. This is to indicate that responses are reliable since respondents are well grounded in inventory management and have spent reasonable time in their jobs to give valid responses to questions asked.

## 4.2 Level of use of Inventory management techniques

To explore the level of use of inventory management in the construction industry, respondents were asked to rate the level of use of 11 inventory management techniques for construction projects using a five-point scale of 1 = never used, 2 = used rarely to 5 = used very frequently. The result of analysis is presented in Table 1.

**Table 1:** Results of analysis for inventory management techniques for projects

| Inventory management tool | Mean | SD | Rank | Skewness | Kurtosis |
|---|---|---|---|---|---|
| Material Requirement Planning (MRP) | 3.972 | 0.825 | 1 | 0.815 | 0.141 |
| Warehousing Management (WM) | 3.961 | 0.813 | 2 | -0.408 | -0.072 |
| First-In-First-Out (FIFO) | 3.880 | 0.870 | 3 | -0.378 | 0.424 |
| Vendor Managed Inventory (VMI) | 3.874 | 0.945 | 4 | 0.081 | -0.641 |
| Recovery & Recycling (R&R) | 3.866 | 0.857 | 5 | -0.741 | 0.575 |
| Material Tracking (MT) | 3.755 | 0.824 | 6 | -0823 | 0.042 |
| Economic Order Quantity (EOQ) | 3.719 | 0.788 | 7 | 0.114 | 0.061 |
| Just-In-Time (JIT) | 3.703 | 1.092 | 8 | 0.004 | 0.031 |
| Always Better Control (ABC) | 3.622 | 0.822 | 9 | 0.161 | -1.241 |
| Material Handling (MH) | 3.544 | 0.765 | 10 | -0.674 | -0.001 |
| Material Transporting System (MTS) | 3.371 | 0.902 | 11 | 0.112 | 0.578 |

**Note**: *SD stands for standard deviation*

It shows that MRP with a mean score of 3.972 is the top ranked technique for construction projects in Nigeria. This is closely followed by WM (3.961) at the second, FIFO (3.880) at the third, and VMI (3.874) at the fourth. However, MTS (3.371), MH (3.544), and ABC (3.622) were the three least rated techniques. The top rating of MRP underscores its significance as a technique that simultaneously allows companies construction companies inclusive to ensure that construction materials are available for

use on time at site and that projects are effectively delivered to clients at the agreed schedule of time and cost. It is instructive to note that all the 11 techniques used for the survey score above 3 points which is to indicate that they are all used in the Nigerian construction industry but with varying degrees of implementation.

All the inventory management tools were also examined for potential outlier and normality. Normality of all the 11 attributes of inventory management was checked by significant test for skewness and kurtosis. According to [31], the observed values of skewness and kurtosis should be tested against null hypothesis of zero because values of skewness and kurtosis are zero when a distribution is normal. The test statistics result for skewness and kurtosis were within an acceptable range as most of the values are close to zero at $p < 0.01$, two-tailed test with the exception of ABC with a kurtosis value of 1.241 (Table 1), meaning that they are normally distributed.

### 4.3 Influence of Inventory Management on Project Performance

In order to explore the influence of use of inventory management techniques on project performance, a hypothesis was postulated. It states that there is no significant correlation between the level of use of inventory management techniques and project performance. The decision rule is that the hypothesis is rejected for all values of $p > 0.05$ while it is accepted for all values of $p < 0.05$. The top three ranked techniques were correlated against three project performance indicators using spearman rank correlation. The results are presented in table 2.

**Table 2:** Results of correlation analysis between use of inventory management tools & project performance

| Correlated variable | R-value | P-value | Decision |
|---|---|---|---|
| **Material Requirement Planning (MRP)** | | | |
| Improved project delivery time | 0.448 | 0.089 | Reject |
| Reduced project cost | -0.211 | 0.114 | Reject |
| Improved quality of project output | 0.102 | 0.001 | Accept |
| **Warehousing Management (WM)** | | | |
| Improved project delivery time | 0.092 | 0.158 | Reject |
| Reduced project cost | 0.244 | 0.499 | Reject |
| Improved quality of project output | 0.178 | 0.000 | Accept |
| **First-In-First-Out (FIFO)** | | | |
| Improved project delivery time | -0.643 | 0.117 | Reject |
| Reduced project cost | 0.533 | 0.284 | Reject |
| Improved quality of project output | 0.281 | 0.024 | Accept |
| **Vendor Managed Inventory (VMI)** | | | |
| Improved project delivery time | 0.402 | 0.401 | Reject |
| Reduced project cost | -0.034 | 0.054 | Reject |
| Improved quality of project output | -0.521 | 0.012 | Accept |

**Note:** *R-value = correlation coefficient; p-value is significant @ p≥0.05*

The results show that the level of use of all the three inventory management techniques had significant influence on two of the project performance indicators used

for the survey. This is because p-values are greater than 0.05. For instance MRP had strong correlation with improved project delivery time (p-value = 0.089), reduced project cost (p-value = 0.114). The hypothesis is therefore rejected. The correlation between MRP and improved quality of project output is however not significant at 5% significance level (p-value of 0.024). Therefore the hypothesis is accepted. This is replica of all other techniques. What this implies is that the use of the three techniques has no influence on improved quality of construction projects as perceived by respondents. This is likely due to the fact that the use of inventory management may not have direct influence on quality of project output but definitely has indirect influence on the quality of projects at the long run.

# 5 Conclusion

Based on questionnaire survey of 90 inventory management professionals, the study examined the concept of inventory management and its influence of project delivery from the perspective of the Nigerian construction industry. Data collected were analysed using descriptive statistics, and spearman rank correlation.

Findings indicate that material requirement planning (MRP), warehousing management (WM), and first-in-first-out (FIFO) are the top most used inventory management techniques in the study area while the level of use of all the top three inventory management techniques had significant influence on two of the three project performance indicators used for the survey. The paper therefore concludes that inventory management is popular in the Nigerian construction industry but with varying degrees of implementation. However, its influence on project delivery is significant only in the areas of time and cost delivery.

The paper therefore recommends that contractors and industry associations should embrace the concept of inventory management to improve efficiency in terms of growth, turnover and sustainability. Besides, stakeholders should carry out advocacy and sensitisation to improve level of awareness while educational construction institutions should update their curriculum to incorporate sustainable and more innovative technologies into inventory management.

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