Inventory Management Strategies For Productivity Improvement In Equipment Manufacturing Firms

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Abstract: This study examined and developed Inventory Management Strategies (IMS) which could be creatively employed for Productivity Improvement in Equipment Firms (PIEMF) Equipment manufacturing projects suffer from declining productivity and inability to effectively satisfy customized order batch quantity within schedules, budgeted cost and quality specifications due to lack of robust and well defined IMS as well as none code classification of vast number of inventory item. Survey and expost-facto research designs were adopted on the four identified IMS in three EMF. The method used for primary data collection and measurement on four IMS and inventory management parameters was questionnaire modelled into likert five point scale from the target respondents being experts in the subject matter. The secondary data was obtained from the computerised inventory status file of the three equipment manufacturing firms. The methods of primary data analysis and test of research used were Pearsons product moment correlation coefficient and oneway. Analysis of variance (ANOVA) computer software via Statistical Program for Social Science (SPSS) version 17 ABC analysis and classification of materials was used for code categorization of secondary data, also with the aid of Microsoft excel. The results of the analyses highlighted and isolated "A" class of inventory items which are 137 out of 543 for Siemens Nig. Ltd, 154 out of 551 for Dresser-Rand Nig. Ltd and 162 of 551 for Nigerian Engineering Works Ltd. The results of Pearson product moment correlation analysis and test of research hypotheses indicate that Materials Requirements Planning (MRP) followed by Supply Chain Management (SCM) are the most significant IMS as they correlate strongly with PIEMF. The study recommends IMS adoption by code classification of materials; in which MRP or SCM could be deployed for management of "A" class of inventories while classical IMS could be used for management "B" and "C" classes of inventory items.

Keywords: Productivity Improvement in Equipment Manufacturing Firms (PIEMF)

INTRODUCTION

Inventory plays a vital role in the operation of an organizations. On the average, inventory constitutes about sixty percent of the current assets in most manufacturing organizations (Hills, 2000). Since manufacturing firms maintain a large size of inventory, a considerable amount of funds is required to commit to them. The high risk of investing such large percentage of funds justifies the need for firms to implement effective and efficient inventory management strategies so as to expect high return on investment and productivity improvement. Inventory management is concerned with the efficient management of stock to achieve an optimum level of inventory in the firm's working capital. Inventory is divided into three major types: raw materials, semi-finished goods and finished goods. The management of inventory involves two close related functions, planning and control of inventory. This has to be done efficiently and effectively to avoid unnecessary investment in inventory. Careful planning and coordination is required to optimize investment in inventory. This is necessary because the financial manager, marketing manager, production manager and the purchasing manager all have peculiar but different interests in inventory management and how it could be managed to contribute to productivity improvement. According to Stevenson (2007), manufacturing firms for instance carry supply of raw materials, purchase parts, partial items and finished goods as well as spare parts for machine tools and other supplies. Fleming (2003), opines that many procurements are routine and simply requires that someone tracks the orders to make sure that commodities arrive in time to support the project schedule and are inspected to make sure that they work and meet all quality standards. Many of the problems of running out of materials and products are obvious, which is a reason why companies sometimes carry more than they need. Too much inventory causes excessive holding cost, extra space requirements, and product obsolescence, and it hides other problems, the company should find the enabling strategies to solve in order to improve productivity. Manufacturing firms or companies hold inventories for a variety of reasons. Inventories of finished goods or finished sub-assemblies may be held so that the company can respond to customer's demand in less than the lead time required to obtain the inputs and produce the products. Finished goods inventories also protect a company from errors of under forecasting demand or in cases when the demand is higher than the production quantity at the particular period. Inventories of inputs protect a company against interruption of supply due to strikes, weather, or other natural disasters. Companies now try to reduce the risk, instead of just looking for the suppliers with the lowest price, they look for suppliers that response to actual demand. The importance of adequate control of inventories become very paramount especially in this period of our economic life (as a supplier or manufacturer) when capital for business use is not easy to come by. Therefore, it becomes unnecessary to tie down the little capital by holding unnecessarily large inventory. This is due to the fact that the inventory of a typical industrial firm comprises of about 10,000 to 50,000 different items (Imaga 2003). Imaga (2003) further states that a study of corporate balance sheets shows that a firm inventory commonly constitutes from 15 to 25 percent of its invested capital and therefore a critical function requiring professional managerial skills. Inventory management is pivotal in effective and efficient organizational management. It is also vital in the control of materials and goods that have to be held (or stored) for later use in the case of production or later exchange activities in the case of services. The principal goal of inventory management involves having to balance the conflicting economics of not wanting to hold too much stock or having to run out of stock, therefore, having to tie up capital so as to guide against the incurring of costs such as storage, spoilage, pilferage and obsolescence and, the desire to make items or goods available when required (quality and quantity wise) so as to avert the cost of not meeting such requirement. (Adeyemi and Salami 2010). Inventory problems of too much or too small quantities on hand can cause business failures. If a manufacturer experiences stock-out of a critical inventory items, production halts could result. Moreover, a shopper expects the retailer to carry the item wanted. If an item is not

stocked when the customer thinks it should be, the retailer loses a customer not only on that item but also on many other items in the future. The conclusion one might draw is that effective inventory management can make a significant contribution to a company's profit as well as increase its return on total assets. It is thus the management of this economic of stockholding that is appropriately being referred to as inventory management. The reason for greater attention to inventory management is that this figure, for many firms, is the largest item appearing on the asset side of the balance sheet. Essentially, inventory management, within the context of the foregoing features involves planning and control.

STATEMENT OF THE PROBLEM

Poor inventory management is the bane of manufacturing firm's performance as it has resulted to the low output ratio on the resource expended. A cursory survey indicates that manufacturing firms such as, Dresser-Rand Nig. Ltd, Siemens Nig. Ltd, and Nigerian Engineering Work Ltd are suffering from low productivity of materials, capital, time and energy management among others which could be attributed mostly to poor inventory management strategies. It could be on this premises that Prepeh (2015) avers that in the manufacturing companies, nearly 60%-70% of the total funds employed are tied up in current assets, which inventory is the most significant component. The Equipment Manufacturing Firms (EMF) have no scientific method of classifying inventories and adopt no specific inventory management strategy, rather they rely on rule-of thumb. As a result, they are characterized by poor business result, low Return on Investment (ROI) and low productivity due to loss order in sales, inability to satisfy customers demand and low capacity utilization. There are incessant cases of inventory surpluses and shortages cost, such as depreciation, pilferage, materials/component parts depreciation and obsolescence, spoilage, breakages etc. shortages of raw materials inventory have resulted in interrupted production, and incessant stock-out, idle facilities and manpower as well as low capacity utilization etc. These have resulted to the failure of the firms to satisfy the performance objectives of customized order quality in the manufacturing projects.

OBJECTIVES OF THE STUDY

The aim of the study is to develop inventory management strategies that will be creatively employed to boost productivity in equipment manufacturing firms in order to satisfy the performance objectives of equipment manufacturing firms vis-a-vis; performance and quality, budget and time to completion. According to Lock (1997), with respect for new product development or to produce a piece of equipment of machinery, ship, aircraft, land vehicle, or some other items of specially designed hardware manufacturing projects are often conducted in a factory or other home-based environment, where the company should be able to exercise on the spot management and provide an optimum environment. The specific objectives, geared towards better management of raw materials inventory for productivity improvement are as follows:

i. To classify and isolate the most valuable (A class) inventory items so as to exercise tight control on them in the course of procurement and accounting by using optimal IMS for PIEMF.
ii. To statistically establish the levels of correlation between inventory management strategies and productivity of EMFs.

RESEARCH QUESTIONS

i. What are the most valuable inventory items to be given tight control for PIEMF?
ii. What are the levels of correlation between inventory management strategies and productivity in the EMFs?

RESEARCH HYPOTHESES

The following research hypotheses were formulated to test and establish the significant levels of correlationship between Inventory Management Strategies (IMS) and Productivity in Equipment Manufacturing Firms (EMFs).

H_{01} The level of correlation between ABC system of IMS and Productivity in EMF is not significant

H_{02} There is no significant correlation between Inventory Management Strategies (IMS) and Productivity in EMFs.

REVIEW OF RELATED LITERATURES

Inventory constitutes a very significant part of the current assets of a manufacturing company. Managers of business organizations have come to realize the significance of exercising some degree of control on the quantity of inventory a company should acquire and keep during any given period of time. For most firms, the investment in inventory is substantial because maintaining inventory allows the firm to independently perform the key activities of production, selling and purchasing. Functional area managers in the purchasing, production, and sales departments typically have considerable managerial control of various inventories. Unfortunately, because of the nature of their jobs, they may not view inventory management from a financial management perspective. A cardinal objective of any efficient system of stores control is to ensure that inventories are available as, and when required for production and sales but at the same time ensuring that too much inventories are not carried in stock. While continuous availability of inventory is absolutely essential for any uninterrupted production and sales flows, a company will not just maintain any quantity of inventory without considering the financial implications of such an action (Braide, 2005). The economic environment of Nigeria as it concerns the manufacturing organizations has been turbulent due to its changing characteristics. This change, due to economic forces such as technology, political instability, social and competition require management foresight to formulate organizational strategies. For many organizations, inventory control perhaps is the single most important control technique that have direct relationships with production, marketing, purchasing and financial policy, (Lucy, 2000). Telsang (2010) asserts that a manufacturing firm generally carries the following types of inventories.

- **Raw materials:** Raw materials are those basic unfabricated materials which have not undergone any operation since they are received from the suppliers, e.g. round bars, angles, channels, pipes etc.
- **Bought Out Parts**: These parts refer to those finished parts, sub-assemblies which are purchased from outside as per the company's specifications.

- **Work-in-Process Inventories (WIP):** These refer to the items or materials in partially completed condition of manufacturing e.g., semi-finished products at the various stages of manufacture.
- **Finished Goods Inventories**: These refer to the completed products ready for dispatch.
- Maintenance, Repair and Operating Inventories: Normally these inventories refer to those items which do not form the part of the final product but are consumed in the production process, e.g., spare machine part, oil, grease.
- **Tools Inventory:** Includes both standards tools and special tools.
- **Miscellaneous Inventories:** Miscellaneous inventories include office stationeries and other consumable items.

Definition of inventory, reasons, objectives and purposes of holding inventories have been discussed by many authors such as Anichebe and Agu (2013), Waters (1989), Telsang (2010) and Ubani (2012) because inventories are vital to the successful functioning of manufacturing organizations. This is because many companies hold inventories as part of their business operation. Inventories make up the most significant part of current assets of most companies especially the manufacturing companies. The need for management to ensure inventory control if properly managed cannot be over emphasized. A firm neglecting inventory management will be jeopardizing its long run profitability and it may end up failing in its business. The definition of inventory has been defined by professional bodies and scholars in different ways. However, for inventory management control to be effective there must be a plan which is the development of objectives in an organization and preparation of various budgets to achieve these objectives. Planning of inventory is very essential in an organization. A firm should be able to determine its optimum level of investment in inventories. This situation can only be possible when the company ensures that stocks are sufficient to meet the requirements of production and sales, and the company must avoid holding surplus inventories and at the same time, it is expensive to have more inventories that are unnecessary because it increases the risk of obsolescence. Against this, a company cannot afford loss of sales because of insufficient inventories and at the same time, it is expensive to have more inventories on hand than necessary. Various departments within the same company adopt different views and attitude towards inventories. For instance, the sales department of a company might desire large inventory in reserve to meet virtually every demand that comes. The production department within the same company would similarly ask for large inventories of materials so that the production system will not be interrupted. On the other hand, the finance department would always request for a minimum investment in investment in inventories so that the fund can be used somewhere else for other purposes. Therefore, inventory control involves the recording and monitoring of stock levels, determining the optimal levels and forecasting future demands and decision. The main aim of inventory control is to minimize cost associated within stock. According to Kotler (2000), inventory management control refers to all the activities involved in developing and managing the inventory levels of raw materials, semi-finished materials (work-in-progress) and finished goods so that adequate supplies are available and the costs of over or under stocks are low. Goods in inventory represent a cost of their owner. The manufacturer has to spend on materials and labour. The wholesaler also has funds tied up when hold inventory. Therefore, the basic goals of the manufacturers are to maintain a level of inventory that will provide optimum stock of lowest cost.

Purposes of Inventory Control and Major Classification

The following are the purposes of inventory control to:

i. Minimize cost
ii. Maximize profit
iii. Maximize the return on investment
iv. Avoid running out of stock
v. Prevent surplus stock that are unnecessary
vi. Keep inventory with an available storage capacity
vii. Control capital investment in order to avoid mismanagement and misappropriation of funds
viii. Maximize sales etc

FACTORS INFLUENCING INVENTORY CONTROL

Two fundamental questions always arise in inventory control:

- How much to buy at one time
- When to buy this quantity

There are four factors that govern the answers to questions.

1. **Requirements**: This has to do with item, time, sales, forecasts and production schedule.
2. **Quantity in stock order**: This stores usually provide such information as inventory status through the stock ledger balances and unfulfilled purchase orders.
3. **Procurement time or Lead-Time**: This is the total length of time required to obtain the material. It consists of two parts – the administrative lead-time and the procurement time.
4. **Obsolescence**: There should be provision made for possible design changes or other factors which would make the material obsolete.
5. **Profitability**: As will be seen from what has been stated earlier, holding inventories is often very expensive. More inventories mean more costs and this has a direct impact on the profitability of any organization.

However, holding stock for a reasonable period though may be expensive but sometimes it creates security that may give rise to product price increase and the resultant effect will be high turnover and profitability. It therefore requires competent inventory management to be able to make profit while holding stock(s).

Factors Influencing Productivity

Factors influencing productivity can be classified broadly into two categories as examined by Hyder (2011), Telsang (2010) and Stevenson (2007) to include:

- Controllable or internal factors and
- Non-controllable or external factors

Table 1: Factors Influencing Productivity

S/N	Controllable (Internal Factors)	Uncontrollable (External Factors)
1.	Product	Structural adjustments (economic and social)
2.	Plant And Equipment	Natural Resources
3.	Technology	Government Policy
4.	Materials	Infrastructure
5.	Human Factors	
6.	Work Methods	
7.	Management Style	
8.	Financial Factors	
9.	Sociological Factors	
10.	Workers Participation	
11.	Incentive Scheme	
12.	Quality Circle	
13.	Working Hours and Conditions etc	

Source: Hyder (2011), Telsang (2010) and Stevenson (2007)

Controllable Factors (Internal Factors)

Product factor: productivity means the extent to which the product meets output requirements. Product is judged by its usefulness. The cost benefit factor of a product can be enhanced by increasing the benefit at the same cost or by reducing cost for the same benefit.

Plant and equipment: These play a prominent role in enhancing the productivity. The increased availability of the plant through proper maintenance and reduction of idle time increases the productivity. Productivity can be increased by paying proper attention to utilization, age, modernization, cost, investment etc.

Technology: Innovative and latest technology improves productivity to a greater extent. Automation and information technology help to achieve improvements in material handling, storage, communication system and quality control. The various aspects of technological factors to be considered are:

- Size and capacity of the plant
- Timely supply and quality of inputs
- Production planning and control
- Repairs and maintenance
- Waste reduction
- Efficient material handling systems

Material and Energy: Effort to reduce materials and energy consumption bring about considerable improvement in productivity. The factors that are to be considered are; selection of quality material and right materials, control of wastage and scrap, effective stock control, development of sources of supply, optimum energy utilization and energy savings.

Human Factors: Productivity is basically dependent upon human competence and skill. Ability to work effectively is governed by various factors such as education, training, experience, aptitude etc. of the employees. Motivation of employees will influence productivity.

Work Method: Improving the ways in which the work is done (methods) improves productivity. Work study and industrial Engineering techniques and training are the areas, which improve the work methods which in term enhances productivity.

Management Style: This influences the organizational design, communication in organization, policy and procedures. A flexible and dynamic management style is a better approach to achieve higher productivity.

It could be obvious that we cannot talk of performance without mentioning productivity; in some cases productivity and performance are interchanged. Productivity is the product of work, though, not a measure of how hard we work but of how we use our skills, our intelligence, imagination and our resources such as human resource, materials and capital to efficiently produce outputs. The term productivity has been identified in many ways though showing difference in terminology than opinions. In Pandey (1999) productivity is the output per man hour. One of the pervasive and enduring objectives of production and operations managers is to improve productivity, thus reducing the cost per unit of output, or increase output with a stable amount of input like material through stock control and other inputs. This will lead to cost reduction and increase in returns. In the words of Hyder (2011), “productivity is the first test of management competence”. This can be achieved through effective inventory management. Productivity is a measure of the efficiency of the transformation process. It is however possible to consider productivity in terms of various basic resources used in the industries and the total revenue accruing from total output of goods and services. From the above, inventory management can contribute to high productivity which will lead to cost and time reduction in production processes thus assisting the organization to achieve its objectives. Every organization must have a goal to achieve. Without setting a goal for an organization, it will be difficult to measure or evaluate productivity. Hence, according to Allison (2000) is an aid to performance.in every organization, inventory management is crucial to maintain corporate performance because without effective inventory management production will be affected which result to idle time and marketing unit will have less finished goods to satisfy customer demands. To measure performance involves ascertaining, the level of accomplishment of a given activity or goal and attempts made to determine the actual level of task accomplishment. Production and volume of sales can be measured to indicate the level of performance for the firm. How frequently measurement is done will depend on the organization. According to Jaja (2004), to determine performance gap involves comparing measured performance against established standard. In this controlling task, actual performance computed will be expected performance to ascertain whether they match or they do not. Matching implies there exists no difference between set standards and performance. But, where they do not match, their difference constitutes the performance gap, which must be filled through the next plan. Constant inventory stocks and regular supplies are taken into consideration when setting performance standard in any organization. Good performance is an indication of the productivity of the firm.

Indices of Productivity

This simply has to do with the yardstick made to measure how a company or an organization has performed within a given period of time. Some of the indices we would like to examine here include Profit, Sales, Output, Market share, Earnings per share, and Profitability ratios. A company should earn profits to survive and grow over a long period of time. Profits are essential, but it would be wrong to assume that every action initiated by management of a company should be aimed at maximizing profits irrespective of social consequences, Profitability ratios are calculated to measure

the operating efficiency of the company. Besides management of the company, creditors and owners are also interested in the profitability of the company. Creditors want to get interest and repayment of principal regularly. Owners want to get a required rate of return on their investment. This is possible only when the company earns enough profits. Generally, two major types of profitability ratios are calculated:

- Profitability in relation to sales
- Profitability in relation to investment

Sales have to do with the total number of products that are sold during a particular period of time. It is one of the indices of corporate performance. When a company makes huge sales it is an indication that it is performing effectively and efficiently, and vice versa. Output is important indices of corporate performance. It is the amount of goods or work produced by a company within a given period of time. If output is big enough, the company is assumed to be effective and efficient. However, if output is small, this will be an indication of low productivity. Market share is also used to examine the success and growth of a company within a given time period. It simply has to do with the percentage of sales in a market that a company has in comparison with the shares of other similar and competing companies.

Inventory Management Strategies

The success of a supply chain business often relies on the effectiveness of its inventory strategy. Without a strong plan in place, companies may run shortage or end up with surplus inventory on hand. To increase efficiencies and meet customer demand, these business should educate themselves on which of the different models of inventory strategies available best meets their need (Dubois 2016). This is an indication that inventory management strategies could correlate to increase efficiencies and productivity improvement. There are classical and non-classical inventory management strategies. The classical inventory management strategies are; Conventional Manufacturing Strategy (CMS), Economic Order Quantity (EOQ) and Economic Production Quantity (EPQ). The non-classical inventory management strategies are Material Requirements Planning (MRP), Just-in-Time (JIT) and Hybrid Push-Pull (HPP) or Lean Inventory Strategies. However, it could be said that classical inventory management strategies are gradually being phased out by some manufacturing firms due to some limitations such as downtimes and idle capacity while waiting for replenishment of inventories or due to congestion as a result of inventory surpluses.

Just-in-Time (JIT) STRATERGY 1

The term JIT is used to refer to an operations system in which materials are moved through the system and services are delivered with precise timing so that they are delivered at each step of the process just as they are needed-hence the name just-in-time (Stevenson 2007). Initially, the term JIT referred to the movement of materials, parts and semi-finished goods within a production system

Material Requirements Planning (MRP) STRATEGY 2

Materials requirements planning employ computer software applications to manage inventory. MRP applications break down inventory requirements into specific periods to keep production running smoothly while maintaining minimum inventory levels. Designed to answer what is needed, how much is needed and when it is needed, this model works backward from the planned finished product to determine the components and raw materials needed to create it. While costly to implement, MRP systems help manages plan for capacity needs and allocate production times. MRP is what Scutter (2014) and Telsang (2010) also described as Push inventory management strategy. Most companies have a better profit and satisfy customers when inventory managers develop an effective and efficient inventory management strategy such as JIT.

Hybrid Push – Pull (HPP) Strategy or Lean Inventory Strategy 3

Some businesses use a hybrid push-pull method to properly manage inventory (Scutter 2014). According to Scutter (2014), to be successful, companies require a sophisticated inventory control system to track products and supplies currently in stock with the ability to properly forecast future demand. This model is also known as a lean inventory strategy in which companies rely heavily on forecasting and constantly adjust inventory levels based on actual sales. Stevenson (2007) defines lean operation as a highly coordinated system that uses minimal resources and produces high-quality good or service.

Supply Chain Management (SCM) STRATEGY 4

SCM is a strategic coordination of business function within a business organization and through its supply chain for the purpose of integrating supply and demand management (Stevenson 2007). According to Ubani (2012), the primary objective of SCM is to reduce risks and uncertainties into supply chain, thereby positively affecting inventory levels, operations and production cycle times, processes and ultimately end users service levels. The focus is on system optimization and enhancement of performance effectiveness.

Method and Materials

Equipment Manufacturing Firms (EMF) were used to study and analyze the level of correlations or influence inventory management strategies have on productivity improvement. According to Waters (1989) and Stevenson (2007) manufacture of one-off-item and equipment are typical projects The Firms are Dresser-Rand Nigeria Limited, Siemens, and Nigerian Engineering works. Combinations of primary and secondary data were used for the study. Primary data was captured with the instrument of well-structured and well standardized questionnaire and oral interview administered to the staff and management of DRR, SIE and NEW firms and technical partners involved in inventory and production management of equipment manufacturing in Rivers State. The target respondents were production managers, materials / inventory managers, instrumentation / electronics engineers, cost accountants, and mechanical engineers. Similarly, the secondary data was obtained from the inventory data base which included list of raw material inventory, the annual demand of raw material inventory, order lead time, unit cost of most valuable raw materials inventory etc. The instrument of data collection was questionnaire modeled in Likert five point scale. Also, secondary data were collected from the EMF from their computer-assisted inventory status file. The data collection was done in two

stages. The first stage involved data collection for the purposes of determining the; "A" class of materials, strength and direction of correlation existing between IMS and PIEMF, and relative influence of inventory management factors/requirements on PIEMF. The second stage was after establishing the most significant, strongest and positive IMS on PIEMF. The optimal IMS were used to obtain data set so as to validate and assess the level of effectiveness of the optimal IMS on the productivity improvement of the three EMF studied. The population of the following category of experts were obtained from the EMF. Production managers, material/inventory mangers, instrumentation/ electrical/ electronic engineers, mechanical engineers and cost accountants. These categories of experts were the target respondents and provided the relevant production and inventory information based on their intuitive opinion for data generation and hence form the population size N of the study. Investigative interview with human resource departments of the three EMF gave N as: DRR = 51, SIE = 44, and NEW = 40.

Data Analysis and Discussions

The data analyses were done in two stages. The first stage used ABC analysis and classification of materials to obtain "A" class of materials, correlation analysis to obtain the most significant (optimal) IMS and RII of inventory factors that influence PIEMF.

(1) ABC Classification and Analysis of Materials

ABC analysis and classification of materials or Pareto analysis will be used to classify and isolate 'A' class of materials usually called capital materials and are most valuable so as to examine their effects and correlations on productivity improvement. According to Ubani (2012), Telsang (2010) and Waters (1989), ABC analysis and classification for inventory management principle used for inventory management problems. In this analysis, the inventories (i.e. the goods) are classified according to their annual usage in terms of money values. The inventories are divided into three categories: A, B, C. The inventory of an industrial organization generally consists of thousands of items with varying prices, usage rate and lead time The concept applied to inventory control is called ABC analysis (Telsang 2010). Statistics reveal that just a few items account for bulk of the annual consumption of the materials. These few items are called 'A' class which hold the key to business. The other items known as B and C which are numerous in number but their contribution is less significant. ABC analysis thus tends to segregate the item into three (3) categories A, B and C on the basis of their annual usage. The categorization is made to pay right attention and control demanded by items based on their importance or value. The raw materials inventory of the EMF will be classified into A, B and C class so as to examine and isolate A class of materials for better control for productivity improvement. The ABC classes of materials are discussed below to provide insight on their relationship with productivity, efficiency and profitability indicators.

i. 'A' type of inventories are most valuable, represents only 20 percent of the materials in inventory and 70 to 80 percent of the total value of the inventories. Therefore 'A' type of inventories requires tight and close control. That is to say that, these items constitute 20 percent of the total inventories. These items require rigid and strict control and need to be stocked in smaller quantities. These items are to be procured frequently and each time less quantity is procured. The inventory of A class items is kept at minimum.
ii. 'B' types of inventories are second to most valuable materials. They represent 30 percent of the materials in inventory and 20 percent of the total value of the inventories and therefore require moderate control. These items represent 20 percent of the total expenditure on materials. These are intermediate items. The control on these items should be intermediate between A and C items.
iii. The 'C' type of inventories represents 50 percent of the materials in inventory, the least valuable and represents 10 percent of the total value of the inventories. Therefore 'C' type of inventories requires loose control. These are about 50 percent in number and constitute only 10 percent of total expenditure on materials.

These items being expensive do not require strict control. These are ordered in bulk as against infrequent ordering of A class items. This approach helps the manager to exercise selective control and focus his attention only on a few items. By exercising strict control on A class items, the material manager is able to show the results within a short period of time. It results in reduced clerical costs, saves time and effort and results in better planning and control and increased inventory turnover. ABC analysis, thus, tries to focus and direct the effort based on the merit of the items and, thus, becomes an effective management control too. However, ABC analysis has limitation as follows: ABC analysis is a fundamental tool for exercising selective control over numerous inventory items but in present form, do not permit precise consideration of all relevant problems of inventory management. ABC analysis is not one time exercise and items are to be reviewed and re-categorized period

(2) Correlation Analysis

The Statistical tool that was used for data analysis and test of hypothesis is correlation analysis. Computer-based correlation analysis software via SPSS was used to determine the level of correlations between inventory management strategies and productivity improvement in EMF. Correlation analysis is a technique used in measuring the closeness of the relationship between variables or among variables. For instance, correlations between variables X and Y can be estimated regardless of whether X affects Y or vise-a-vise, both affect each other; neither affects the other, or they move together because some third variable influence both. Anichebe and Agu (2013) used Pearson product moment of correlation coefficient and linear regression to study the effects of inventory management on organizational effectiveness and found that inventory management significantly affects productivity improvement with $r = 0.614$, $t = 11.175$, $p<0.05$. Therefore, correlation coefficient 'r' measures the strength of the relationship between variables, and cannot give any information on causation.

Questionnaire distribution and returns by EMF

Table 2

Equipment manufacturing firm	Number of questionnaire		Percentage
		Returned	
DRR	51	40	78.43
SIE	44	38	86.36
NEW	40	34	85.00
	135	**112**	**82.96**

Table 3

Distribution of Returned completed questionnaire by technical and managerial experts

Respondents/Experts	Equipment manufacturing firms			
	DRR	SIE	NEW	TOTAL
Materials/inventory managers	12	14	10	36
Production managers	15	13	14	42
Instrumentation/Electrical/electronic engineers	6	4	3	13
Cost accountants	3	3	4	10
Mechanical engineers	4	4	3	11
Total	**40**	**38**	**34**	**112**

Quantitative Data Analysis and Test of Research Hypotheses

The methods used in this stage were:

(i) ABC analysis and classification of materials for categorization of materials inventory.

According to Table 4. The most valuable inventory items in ranking order that indicated approximately 70% of total inventory cost, when compared with the theoretical foundation shows that Siemens Nig. Ltd is very close to the theoretical distribution pattern of 20% of total units to 70% of total value. This is followed closely by inventory items at Dresser. Rand Nig. Ltd and Nigerian Engineering Works Ltd. The distribution pattern of their inventory items as per ABC do not vary too much from the theoretical values. According to Waters (1989) in materials management, the ABC analysis (or selective inventory control) is an inventory categorization technique. “A items” require very tight control and accurate records, “B items with less tight control and good record and “C” items with simplest control minimal record. This analysis has provided a mechanism for the EMF in identifying items that will have significant impact on overall inventory costs for tight control and management so as to boost PIEMF. “A items” are very important for the EMF. Because of the high value of these “A items” frequent value analysis is required as well as to choose appropriate order pattern. Example of ABC class are that

(ii) Pearson product moment correlation analysis for test of research hypotheses

Summary of paired sample Pearson Product Moment Correlation Analysis results with four IMS in the three EMFs According to table 5 IMS_2; MRP ranked first with mean values of Pearson Product Moment with Correlation Coefficient (R) = 0.849 and p – value = 0.0001. The results could attest to the fact that MRP effectively determines what components are needed, how many are needed, when they are needed and when they should be ordered so that they are available as needed. Also, MRP insist on the right quality and well calculated order size, all these combinations provide savings in costs, time, labour, materials and energy, hence productivity improvement. Unlike JIT, MRP can handle large quantity of inventories, better control of in-process inventory and stock and maintain large quantity of customized order quantity of finished products. The performance of MRP is because of its two major unique characteristics of dependent demand and requirements explosion resulting to generation of bill of materials needed to satisfy the specific customized order quantity as well as satisfies the performance objectives of manufacturing projects in EMF. The demand for items in MRP is derived from plans to make certain products, as it is with raw materials, parts, subassemblies etc used in producing customized order quantity of finished products. The aggregate contribution of these performance indicators could adduced the reasons for the ordered ranking positions of IMS which indicates that MRP (IMS_2) is the most significant and favourable IMS for PIEMF. MRP therefore favours the achievement of customized order quantity of products within the scheduled time, budgeted cost and quality specifications. The research indicates that MRP, when creatively employed in EMF, almost rigorously follow and concur with theoretical concepts and available empirical evidence in terms of performance level of success in productivity, profitability and effectiveness, but not without few criticisms. MRP has been used by many researchers in EMF and other related companies with impressive success in cost reduction, time savings, productivity improvement, profitability etc.

FINDINGS

Based on the research methodology and methods of data analysis adopted for the study, the research findings are summarized into phases as follows: Identifications of Four Non-classical Inventory Management Strategies. The study identified and examined four non-classical Inventory Management Strategies; (IMS) namely: Just-In-Time (JIT), Material Requirement Planning (MRP), Lean and Supply Chain Management (SCM).

Development of two most favourable IMS for PIEMF

i. Out of four non classical IMS identified for the study, vis-à-vis Just-in-Time (JIJ), Material Requirements Planning (MRP), Lean System (Lean) and Supply Chain Management (SCM), only MRP and SCM were found to correlate strongly with PIEMF.
ii. The method of Pearson product moment correlation analysis was used and the result indicated that MRP followed by SCM are the most significant IMS for PIEMF. JIT and lean, were not found to be significant IMS for PIEMF. MRP and SCM strategies have the capacity to effectively manage inventory items in manufacturing projects so as to satisfy the customized customers batch order quantity within schedule, budget cost and quality specifications. Categorization of inventory materials items and isolating the most critical materials usually referred to as “A class” or capital materials.
iii. ‘’A’’ class of inventory requires proper attention, tight control and therefore necessitates the deployment of the most favourable optimal inventory management strategies on them for Productivity Improvement in Equipment Manufacturing Firms (PIEMF).

The secondary data of inventory data file from the three EMF indicate that they operate with large quantity of inventory items which could be impossible to track and control each of them at a time if without code classification. From tables 4 respectively, the number of manufacturing materials inventory items three for the EMFs’ Siemens Nig. Ltd (SIE),

Dresser-Rand Nig. Ltd (DRR) and Nigerian Engineering Works (NEW) are 543, 551 and 551 respectively. The study adopted the technique of ABC analysis and classification of materials and identified, highlighted and isolated the number of most valuable a class of materials in each EMF as follows: SIE = 137, DRR = 154 and NEW = 162. The study reduced the inventory items to manageable size based on usage value so as to facilitate and position them for close and tight control. They account for more than 70% procured frequent and stock in smaller quantity. These items are usually procured frequently and stock in smaller quantity. They account for more than 70% of the total money spent on inventory. Deployment and management of these "A class" item with robust Inventory Management Strategy (IMS) will boost PIEMF by reducing cost, time, labour and energy while increasing profit.

CONCLUSION

The study has examined and delved into IMS for PIEMF. There is high demand for these equipment because of multiple economic activities especially with respect to oil and gas that use the equipment in large numbers as the demand is relatively high. Also the sampled EMF maintain and stock large quantities of different types of items, which has made it so complex and costly to manage, coupled with lack of code classification and well defined strategy on ground. As a result, the EMF are not properly coping up in satisfying customized batch order quantity with the objective parameters. The non-classical inventory management strategies were identified and subjected to Pearson product moment correlation analysis. MRP and SCM were deduced to correlate strongly with PIEMF. Also ABC analysis and classification of materials categorised the materials. "A class" of inventories were isolated for proper attention and close control because manufacturing projects are expected to perform better when MRP or SCM is applied to control "A class" of materials in particular. The levels of influence of inventory management parameter on PIEMF were evaluated and ranked in order of priority and driving force to achieve PIEMF.

RECOMMENDATION

In the line with the findings the following Recommendations are made:

i. Updated computer software's should be installed to facilitate customers order processing, maintain accurate inventory accounts and better management of inventories for PIEMF.
ii. Due to many items of inventory in EMF ranging from 543 to 551, MRP and SCM applications should be limited to "A" class of materials only as attempt to extend them to "B" and "C" classes of materials will create confusion and complexity capable of marring the success of manufacturing products. However, classical IMS such as Economic Order Quantity can be deployed to manage "B" and "C" classes of inventories.
iii. SCM should adopt the modern Information Technology (IT) facilities in its operations in order to effectively coordinate buyers and suppliers with production so as to achieve timely and cost effective delivery of goods and productivity improvement throughout the system. Example of such advanced IT is Radio Frequency Identification (RFID). Advances in technology are revolutionizing the way businesses track goods in their supply chains. RFID is a technology that uses radio waves to identify objectives such as goods in supply chains.
iv. There should be collaborative planning, forecasting and replenishment, which is a supply chain initiative that focuses on information sharing, among supply chain trading partners in planning, forecasting and inventory replenishment, as these will favour effective operations in manufacturing projects.
v. There should be human resource development in the areas of cost estimations for efficient utilization of working capital, economy of purchasing and manufacturing projects. It should be recalled that accurate estimation of inventory costs significantly influence PIEMF.
vi. Scheduled productions of items should be integrated into the MRP logic while taking into considerations production and materials order lead times respectively.

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