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A Correlational Study on Inventory Management Strategies for the Improvement of Equipment Manufacturing Firms

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Abstract- **Most manufacturing firms suffer from decline in performance and the inability to effectively satisfy customized order within schedule, budget and quality specifications which are largely attributed to lack of a robust and well defined inventory management system. This study examined how inventory management strategies (IMS) could be creatively deployed into the Improvement of Equipment Manufacturing Firms (IEMF) via a correlational study. Survey research design was deployed on four identified IMS in three EMF. A structured questionnaire was used for primary data collection and measurement on the four (4) IMS modelled in a Likert five point scales. The data were analysed using the Pearson's product moment correlation coefficient via Statistical Package for Social Science (SPSS) version 17. The results of Pearson product moment correlation and test of research hypotheses indicates that Materials Requirements Planning (MRP) and Supply Chain Management (SCM) are the most significant IMS as they correlate strongly with IEMF.**

Keywords- **Just-in-Time, Lean, Materials Requirements Planning, Push-Pull, Supply Chain Management.**

I. INTRODUCTION

Inventory plays a vital role in the operation of an organization. On the average, inventory constitutes about sixty percent of the current assets in most manufacturing organizations [1]. 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. Inventory management is concerned with the efficient management of stock to achieve an optimum level of inventory in a firm's working capital. Inventory is divided into three major types: raw materials, semi-finished goods and finished goods.

According to Stevenson [2], manufacturing firms for instance carry out the supply of raw materials, purchase parts, partial items and finished goods as well as spare parts for machine tools and other supplies. Fleming [3], opines that many procurements are routine and simply requires that someone tracks the orders to make sure that commodities arrive in time to support project schedule and are inspected to make sure that they work and meet all quality standards [4].

Studies on corporate balance sheets shows that firm's inventory commonly constitutes between 15 to 25 percent of invested capital and therefore a critical function requiring professional managerial skills is required. 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 item, 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.

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.[5]. These have resulted to the failure of the firms to satisfy the performance objectives of customized order quantity in the manufacturing firms.

Poor management of these raw materials inventory have tied capital down and prevent capital from being released for production thus, resulting to poor return on investment (ROI) and low productivity. It is on these premise that [6] traces high cost of production to insufficient supply of raw materials, high cost of capital, poor utility supply and operational delays.

These problems are harmful to the survival of manufacturing firms and therefore require proactive and decisive measures to address them through inventory management strategies in order to always meet up with the customized order quantity and also save the manufacturing sector of the economy from total collapse.

The objectives of the study are to statistically establish the levels of correlation between inventory management strategies and improvement of EMFs. The following research hypotheses were formulated to test and establish the significant level of correlation between Inventory Management Strategies (IMS) and Improvement in Equipment Manufacturing Firms (EMFs).

H_{01} The level of correlation between Just-in-Time (JIT) system of IMS and improvement in EMF is not significant.

H_{02} There is no significant correlation between Material Requirements Planning (MRP) of IMS and improvement in EMFs.

H_{03} There is no significant correlation between hybrid push-pull/lean IMS and improvement of EMFs.

H_{04} The level of correlation between Supply Chain Management (SCM) of IMS and improvement of EMF is not significant.

H_{05} The effectiveness of inventory management strategies on the improvement of EMF is not significant.

II. LITERATURE REVIEW

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.

Definition of inventory, reasons, objectives as well as the purpose of holding inventories have been discussed by authors such as [7],[8],[9] and Ubani [10] 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.

Inventory is the stock of any item or resource used in an organization, while an inventory system is a set of policies and controls that monitors levels of inventory and determines what level should be maintained, when stock should be replenished, and how large orders should be made [11].

Individual scholars such as [12] defined inventory management control as the means of ensuring that actual flow of inventory in an organization conforms to plan. Similarly, [13] defined inventory management control as the techniques used by store managers to ensure that materials are made available when they are needed in the quantity, quality and price that they are needed without the risk of stock and over stocking.

A firm might also decide to hold additional amounts of stock to cover the possibility that it may have under estimated its future production and sales requirements. This represents a precautionary motive, which applies only when future demand is uncertain. The speculative motive for holding inventory might entice a firm to purchase large quantity of materials than normal in anticipation of making abnormal profit. Advance purchase of raw materials in inflationary times is one form of speculative behavior.

Inventory has four basic functions and these functions must be understood if inventory must be analyzed to determine how much inventory is needed. These functions are:

(1) *The Lot size Inventory:* Most companies manufacture items in lots, rather than the exact amount they are required. As a result of this, inventory in excess of immediate requirements will be carried.

(2) *Fluctuation Inventory:* These inventories exist because of demand and supply fluctuations. Safety stock is fluctuation inventory.

(3) *Anticipation Inventory:* These are inventories that are built in anticipation of the future demand. Anticipation inventory helps to build-up inventory during the

slack period in order to retain the labour employed and this will help to provide for demand during peak periods. Inventory build-ups ahead of holiday seasons, anticipation of strikes, and provision of initial inventory of new product and promotion items are also anticipation inventory.

(4) *Transportation Inventory:* These inventories are those materials which are moved from place to place. A company with a plant in point A and stock point at B would normally have considerable amounts of inventory in transit between the plant and stock point warehouse.

Similarly, Lucy [14], classified manufacturing equipment as:

1. Raw Materials:

This is defined as an unprocessed natural product used in manufacturing processes. [15] defined raw materials as direct materials in stock awaiting use in a manufacturing process. [16] defined raw materials as those basic inputs that are converted into finished products through the manufacturing process. This usually consists of the essential items needed to create or make a finished product.

2. Work in Progress:

This can be defined as an incomplete ongoing piece of work. It also refers to items that are partially completed but are not yet finished products. It also refers to the stock of all materials in which processing has commenced but it is not yet completed. Such materials are usually found between raw materials and finish goods. While work-in-progress is partly finished goods and material sub-assemblies between manufacturing stages.

3. Finished Goods:

These are the products that are completed and are ready to be purchased by consumers. [17] defined finished goods as those products that are completed and are ready for sale. Stock of raw materials and work-in-progress facilitates production while stock of finished goods is required for smooth marketing operations.

There are many reasons why organizations maintain inventory of goods. The fundamental reasons for doing so is that it is either physically impossible or economically unsound to have goods manufactured whenever they are demanded for. Without inventory, goods as well as customers would have to wait until they are ordered for manufacture.

According to [7], manufacturing organizations hold inventories for a variety of reasons. Inventories perform significant functions in the total production system and since "it is physically impossible and economically impracticable for each stock of item to arrive exactly where and when they would be needed", there is need to keep some amount of inventory at any point in time.

A. Strategies for Inventory Management

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. The strategies are:

(i) Just-in-Time (JIT)

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 [2]. Initially, the term JIT was referred to the movement of materials, parts and semi-finished goods within a production system. [18] described it as a Pull system of inventory management strategy. Similarly, Just-in-Time (JIT) could be said to be synonymous with Theory of Constraints (TOC). According to [19], a study on the comparison of JIT, TOC and traditional methods indicates that it is difficult to conclude with confidence that one of the systems above is better than the other. [2] asserts that TOC uses a drum-buffer-rope conceptualization to manage a system, which provides a basis for developing a schedule that achieves maximum output and shorter lead times while also avoiding carrying excess inventory. It also ensures on-time delivery and reduction in disruptions that requires expediting. These characteristics of TOC are similar to those of JIT. Similarly, Constant Work-in-Process (CONWIP) and Kanban are general approaches to controlling Work-in-Process in JIT [2].

(ii) Material Requirements Planning (MRP)

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. While it is costly to implement, MRP systems help manages plan for capacity needs and allocate production times. MRP is what [18]; [20] and [9] also described as push

inventory management strategy. Most companies make profit and satisfy customers when inventory managers develop an effective and efficient inventory management strategy such as JIT. According to [9] and [21], "MRP is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements". Raw materials, component parts and sub-assemblies are examples of dependent demand items. MRP is one of the powerful tools that, when applied properly, helps managers in achieving effective manufacturing control.

[2] avers that a major distinction in the way inventories are managed results from the nature of demand for those items. When demand for items is derived from plans to make certain products, as it is with raw materials, parts and sub-assemblies used in producing a finished product, those items are said to have dependent demand.

(iii) Supply Chain Management (SCM)

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 [2]. The sequence begins with basic suppliers of raw materials and extends all the way to the final customer. Functions and activities include forecasting, purchasing, inventory management, quality assurance, scheduling, production, distribution and delivering and customer service. According to [10], 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 [22].

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

Some businesses use a hybrid push-pull method to properly manage inventory [18]. According to [18], to be successful, companies require a sophisticated inventory control system to track products and supplies currently in stock with the intent 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. [2] defines lean operation as a highly coordinated system that uses minimal resources and produces high-quality goods or service. Lean operation depends on having high quality processes in place. Quality is an integral part of lean operation, without high process quality, lean operation cannot exist.

In summary, the identified inventory management strategies were subjected to statistical test to establish their level of correlation and favourable influence to the improvement of EMF as each of the IMS has merits and demerits.

III. RESEARCH METHODOLOGY

The study adopted a combination of survey and ex-post factor research designs. Survey research design could be described as pre-test or longitudinal study which follows a long period of time with repeated data collection. Most of them are observational studies that seek to identify a correlation among various factors. The primary data for the analysis on the study of IMSI in equipment manufacturing firms was obtained by opinion poll using the instrument of questionnaire modeled in Likert five point weighted scale, which is based on scoring of opinion and perceptions of respondents on IMSI of equipment manufacturing firms in Rivers State. The Likert scale involves a test of statement related to the attitude in question and in which respondent is required to indicate the degree of agreement or disagreement with each of the statement [23]. A numerical score was assigned to each degree of agreement or disagreement. The opinion and perceptions of respondents consisting of experts in production/project managements/inventory management, instrumentation/electronic engineering as well as cost accountants.

Ex-post factor research design is a retrospective study which investigates a phenomenon or issue that has occurred in the past. A pilot study was conducted to pre-test the study and instrument on a manufacturing firm located in Port Harcourt, Rivers State. The firm is a small equipment manufacturing and packaging company which maintains different types of raw materials' inventory of different designs, sizes, configuration and specifications. The results generated from the pilot study provided confidence for validation of the study. The result of pilot study was found to be consistent and was replicated in the study of Inventory Management Strategies for Improvement (IMSI) in Equipment Manufacturing Firms (EMF).

The data obtained was subjected to Computer-based correlation analysis on the four IMS in the Improvement of Equipment Manufacturing Firms (IEMF). The target population was obtained from the human resources department of the sampled selected EMF in Rivers State of Nigeria. The research involved a population of production and material/inventory management and engineering instrumentation/ electrical/ electronic engineers, mechanical engineers as well as cost accountants experts in EMF. These categories of experts were the targeted respondents that provided relevant production and inventory information based on their intuitive and opinion on data generation and as such they form part of the population *N* of the

study. Investigative interview with human resource departments of the three EMF gave N as: Dresser Rand (DRR) = 51, Siemens (SIE) = 44, and Nigerian Engineering Works (NEW) = 40.

A judgmental and quota sampling was adopted in identifying the population within the EMF in Rivers State. The judgmental sampling techniques is one of the most important none probability sampling technique. The sample size *n* was determined from *N*, using Taro Yamane formula:

$$n = \frac{N}{1 + Ne^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where *e* = error margin usually 0.05.

However, the N for each of the EMF was so small, < 50 and therefore the N was used as n (ie N=n). The reason could be that the number of technical experts in such an EMF is small due to their unique dexterity.

The study used well-structured and standardized questionnaires based on Likert five-point scale and administered to target respondents in the field. Out of the *N* which is equal to *n* in this study, the number of completed and retained questionnaires was: DRR = 40, SIE = 38, NEW = 34 as against 51, 44 and 40 respectively.

The data analyses were done using the Pearson's product moment coefficient by using the significant IMS on one hand, while the test of hypothesis was carried out using findings from the correlation analysis. Computer-based correlation analysis software via SPSS was used to determine the level of correlations between inventory management strategies and improvement in EMF. Correlation analysis is a technique used in measuring the closeness of the relationship between variables or among variables. Correlation coefficient 'r' measures the strength of the relationship between variables, and cannot give any information on causation. The mathematical methods of measuring correlation are the product-moment correlation coefficient (r_p) and the Spearman rank correlation coefficient (r_r).

$$Where\ R_p = \frac{\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{\left[\sum x_i^2 - \left(\sum x_i\right)^2\right]\left[\sum y_i^2 - \left(\sum y_i\right)^2\right]}} \quad - - - - - -$$

The Spearman rank correlation procedure was used to calculate alternative measure of correlation. This measure of association is based on the ranks of the measurement for each variable rather than on the values assured by the variables themselves. The r_r is applicable and in addition r_r can be used in situation in which the use of product moment correlation method is not appropriate, such as in cases where the relationship between variables are not linear.

$$R_r = 1 - \frac{6\sum d_i^2}{n\left(n^2 - 1\right)} \quad - - - - - - - \quad 3$$

Where *di* = difference between assigned ranks, i – 1,2 - - - - n,

The test for significance of *r* follow *t* = statistics,

$$T = r\sqrt{\frac{n-1}{1-r^2}} \quad ----------4$$

Where n =Sample size, at *n – 2* degree of freedom. All test of hypothesis were done at 5% significant level.

IV. RESULTS AND DISCUSSION

The population sizes were used as sample sizes for the study. As a result of this, 51, 44 and 40 copies of questionnaire were distributed respectively to each of the three EMF and the completed and returned copies are shown in table 1.

TABLE 1. QUESTIONNAIRE DISTRIBUTION AND RETURNS BY EMF

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

The opinion research and deductive reasoning of these categories of experts were examined and studied to ascertain the level of correlation between inventory management strategies (IMS) and Improvement in Equipment Manufacturing Firms (IEMF). The IMSs that were studied in the course of the research are:

IMS_1= Just-in-Time

IMs_2 = Material Requirements Planning (MRP)

IMS_3 = Lean or Push-Pull

IMS_4 = Supply Chain Management

The test of research hypotheses was carried out using the Pearson product moment method of correlation based on paired sample test. For each IMS, the EMF pairs are: SIE/DRR, DRR/NEW and SIE/NEW respectively. The hypotheses were tested using SPSS at 5% significance level.

A. Hypothesis One

Ho_1: The level of correlation between Just-in Time (JIT) system of inventory

management strategy IMS, and IEMF is not significant.

TABLE 2. (A) CORRELATION ANALYSIS FOR SIE/DRR

	SIE	DRR
SIE Pearson Correlation	1	.204
Sig. (2-tailed)		.219
N	38	38
DRR Pearson Correlation	.204	1
Sign. (2-tailed)	.219	
N	38	40

TABLE 2. (B) CORRELATIONS ANALYSIS FOR DRR/NEW

	DRR	NEW
DRR Pearson Correlation	1	.255
Sig.(-2tailed)		.146
N	40	34
NEW Pearson Correlation	.255	1
Sig. (2-tailed)	.146	
N	34	34

TABLE 2.(C) CORRELATIONS ANALYSIS FOR SIE/NEW

	SIE	NEW
SIE Pearson Correlation	1	.242
Sig.(-2tailed)		.068
N	38	34
NEW Pearson Correlation	.242	.1
Sig. (2-tailed)	.068	
N	34	34

The data set for the pairwise Pearson product moment correlation are shown in tables 2 (A, B and C) above. The result indicated in the tables above shows that none of the pairwise samples; SIE/DRR, DRR/NEW, and SIE/NEW is significant at 95% confidence interval. The study

The results of pair wise correlation analysis using Pearson product moment method are shown in table 3. (A, B and C) above. The results of all the paired samples are significant at 95% confidence interval with high coefficients of correlation (R) and p- values. The study concludes that MRP correlates well with IEMF when employed in manufacturing firms. Hence there is a significant correlation between IMS_2 (MRP) and IEMF. The level of IEMF depends strongly on the performance of MRP. MRP therefore needs special attention viz; monitoring and control in order to impact positively on the IEMF in Rivers state Nigeria.

C. Hypothesis Three

Ho_3: The level of correlation between lean inventory management strategy (IMS_3) and IEMF is not significant.

TABLE 4. (A) CORRELATIONS ANALYSIS OF SIE/DRR

	SIE	DRR

therefore concludes that there is no significant correlation between JIT (IMS_1) and IEMF. Therefore JIT will not favour IEMF in Rivers state Nigeria.

B. Hypothesis Two

Ho_2: There is no significant correlation between IMS_2 (MRP) and IEMF

TABLE 3. (A) CORRELATIONS ANALYSIS FOR SIE/DRR

	SIE	DRR
SIE Pearson Correlation	1	.902
Sig.(-2tailed)		.000
N	38	38
DRR Pearson Correlation	.902	.1
Sig. (2-tailed)	.000	
N	38	40

TABLE 3. (B) CORRELATIONS ANALYSIS FOR DRR/NEW

	DRR	NEW
DRR Pearson Correlation	1	.916
Sig.(-2tailed)		.000
N	40	34
NEW Pearson Correlation	.916	1
Sig. (2-tailed)	.000	
N	34	34

TABLE 3. (C) CORRELATIONS ANALYSIS FOR SIE/NEW

	SIE	NEW
SIE Pearson Correlation	1	.728
Sig.(-2tailed)		.002
N	38	34
NEW Pearson Correlation	.728	1
Sig. (2-tailed)	.002	
N	34	34

SIE Pearson Correlation	1	.075
Sig.(-2tailed)		.655
N	38	38
DRR Pearson Correlation	.075	.1
Sig. (2-tailed)	.655	
N	38	40

TABLE 4. (B) CORRELATIONS ANALYSIS OF DRR/NEW

	DRR	NEW
DRR Pearson Correlation	1	.612
Sig.(-2tailed)		.000
N	40	34
NEW Pearson Correlation	.612	.1
Sig. (2-tailed)	.000	
N	34	34

TABLE 4. (C) CORRELATIONS ANALYSIS OF SIE/NEW

	SIE	NEW
SIE Pearson Correlation	1	.0272
Sig.(-2tailed)		.880
N	38	34
NEW Pearson Correlation	.027	.1
Sig. (2-tailed)	.880	
N	34	34

The result indicate that only a paired sample; DRR and NEW were found to be significant at 95% confidence interval. The level of adoption and management of lean strategy in EMF will not correlate closely with IEMF in most of the cases.

TABLE 5. (A) CORRELATIONS ANALYSIS OF SIE/DRR

	SIE	DRR
SIE Pearson Correlation	1	.596
Sig.(-2tailed)		.016
N	38	38
DRR Pearson Correlation	. 596	.1
Sig. (2-tailed)	.016	
N	38	40

TABLE 5. (B) CORRELATIONS ANALYSIS OF DRR/NEW

	DRR	NEW
DRR Pearson Correlation	1	.688
Sig.(-2tailed)		.006
N	40	34
NEW Pearson Correlation	. 688	.1
Sig. (2-tailed)	.006	
N	34	34

TABLE 5. (C) CORRELATIONS ANALYSIS OF SIE/NEW

	SIE	NEW
SIE Pearson Correlation	1	.524
Sig.(-2tailed)		.020
N	38	34
NEW Pearson Correlation	. 524	.1
Sig. (2-tailed)	.020	
N	34	34

The results indicate that all the three pair wised samples were found to be significant at 95% confidence interval with high values of correlation coefficient and p-value. However, the mean significant values of IMS_4 is slightly and relatively less than that of IMS_2. The mean values of results of correlation analysis are shown on table 6 below.

D. Hypotheses Four

$H0_4$: The level of correlation between SCM (IMS_4) and IEMF is not significant

TABLE 6. SUMMARY OF PAIRED SAMPLE PEARSON PRODUCT MOMENT CORRELATION ANALYSIS RESULTS WITH FOUR IMS IN THE THREE EMFS

		Paired Sample of EMF					
		SIE/DRR	DRR/NEW	SIE/NEW	Mean value	Rank	Remark
IMS_1	Pearson correlation (R)	0.204	0.255	0.242	0.234	4th	Not Significant
	Sig (2-tailed) P –value	0.219	0.146	0.068	0.144		
IMS_2	Pearson correlation (R)	0.902	0.916	0.728	0.849	1st	Significant
	Sig (2-tailed) P –value	0.000	0.000	0.002	0.001		
IMS_3	Pearson correlation (R)	0.075	0.612	0.028	0.238	3rd	Not significant
	Sig (2-tailed) P –value	0.655	0.000	0.880	0.512		
IMS_4	Pearson correlation (R)	0.596	0.688	0.524	0.603	2nd	Significant
	Sig (2-tailed) P –value	0.016	0.006	0.020	0.014		

The results discussed here are significantly ranked in order of IMS in other to ascertain and examine the reasons for the trends and directions.

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 required. Also, MRP insists on the right quality and well calculated order size, all these combinations provide savings in costs, time, labour, materials and energy, hence improvement in EMF.

The authors reinforce this assertion by observing that in some industries, labour cost will become trivial, and materials cost will become the central focus in the control of production cost. On the average, 60 percent of manufacturers' sales values are paid to suppliers for the purchase of materials [4]. [20] in their study found that the most known and widely used materials planning methods includes the re-order point systems, run-out time planning, MRP, Kanban and order-based planning, etc.

The MRP interactive capability with computers and information technology facilities has made the strategy to record more successes not only in EMF but also in other manufacturing firms. For instance, [21] in their research on performance improvement study for MRP parts explosion in ERP Environment similarly found that parts explosion is the main process involved in MRP whose purpose is to generate time phased

production and purchase order information based on the master schedule, bill of materials and inventory record.

The inference from the results of the analyses and tests of research hypotheses indicate that MRP is most favourable IMS for IEMF. Empirical evidence shows that it has performed successful in many manufacturing projects and EMF. The results of the study irrespective of pitfalls of MRP have been substantiated by empirical studies conducted by researchers in similar manufacturing firms. MRP has therefore provided avenue to boost IEMF when creatively applied as an inventory management strategy.

SCM ranked second as the most significant IMS for IEMF. For EMFs to creatively and successfully adopt SCM, it will require trust among trading partners, effective communication, supply chain visibility, even management capability and performance metrics. In 1999, [22] similarly studied and found that IBM employed SCM to do what would have seemed to be a near impossible task. And although supply chains are viewed sequentially, IBM did not necessarily managed it in that way in its deal with Contract Manufacturers (CM). Rather it used internet resources to manage multiple tiers of suppliers simultaneously. According to [22], the internet's simplicity reduces costs in 1999 by moving procurement to the Web and that is only the tip of an ice-berg. It was also found to be a tool to work with suppliers to improve quality and reduce costs. Much of the savings came from eliminating intermediaries. It could be on the same note that SCM when interfaced with www could achieve the objective of IEMF, hence the need for development of SCM so as to foster efficiency in EMF. It could also be on these premise that previous studies found that the SCM practices that have been implemented more frequently includes obtaining customers feedback on service adequacy, determining customers future needs, integration of product development activities with suppliers, collaboration of suppliers with demand forecasting, consulting customers to support decisions about new products, integration of product development activities with customers [5].

Therefore, successful supply chain management in EMF requires integration of all aspects of the supply chain, suppliers, warehouse, distributors, and retail outlets. This requires co-operations among supply chain partners in planning, co-ordination of activities, and information sharing, which in turn, requires partners to agree on a common goal (goal sharing).

From tables 2. (A, B and C) for IMS_3, it is only the paired sample, DRR and NEW that is significant, others are not significant. The reason for this trend of result could be adduced to the fact that IMS_3 could not manage and maintain large quantity of supplied inventory items of materials. Also, it could not operate and cope up with large quantities of work-in-process and finished products to satisfy customized order quantity from customers. Unlike JIT, lean has computerized component. Lean manufacturing thus produces goods with few people, little inventory and little waste. According to [9], inventory levels are very low in lean because of use of JIT and it could infer inability to handle large quantity of inventory needed to effectively satisfy customized order quantity usually encountered in EMF.

From table 6, IMS, ranked 4^{th} or last in the order of significance with mean values of R = 0.234 and p – value = 0.144. The trend of the result could be adduced to the inability of JIT system to stock, operate, cope and handle large order quantity of materials and; maintain and stock customized large order quantity of finished products to meet customers due dates.

JIT purchasing is a major component of JIT manufacturing system. According to [9], the basic concept of JIT purchasing is to establish agreement with vendors to deliver small quantities of materials/parts just in time for production. The approach is quite in contrast to traditional approach of bulk buying. [10] opined that for JIT purchasing, materials and components are purchased in accordance with well-defined requirements in terms of quality, quantity and delivery. The JIT IMS is usually designed to synchronize with production processes so as to eliminate wastes of; overproduction, waiting, processing itself, stocks, motion. JIT has some unique characteristics as IMS, such as small lot sizes and minimum set-up time, and buffer stock removal. It could be as a result of these characteristics that JIT was found based on the analysis as not being a significant IMS for EMF. The operations of EMF require computer data base for order processing, inventory status file; bill of materials, inventory accounting etc so as to drive the success of EMF improvement. Though is a popular IMS for Toyota manufacturing in Japan, it has been investigated for non-performance in IEMF in River State of Nigeria.

TABLE 7. COMPOSITE SUMMARY OF QUANTITATIVE RESULTS BASED ON THE DIFFERENT TECHNIQUES OF ANALYSIS

S/n	Requirement	Method of Data Analysis	Indications	Mean result of test statistic/Index	Result in Ranking Order	Remarks
1.	Correlation of IMS	Pearson Product	JIT	R=0.234, Sig.=0.144	MRP	Significant

	and IEMF	movement correlation analysis	MRP	R=0.849, Sig.=0.001	SCM	Significant
					Lean	Not Significant
					JIT	Not Significant
			Lean	R=0.238, Sig.=0.512		
			SCM	R=0.603, Sig.=0.014		

V. CONCLUSIONS

Based on the research methodology and methods of data analysis adopted for the study, the research findings are summarized into phases as follows:

The study has examined and delved into IMS for IEMF in the Rivers State Nigeria. There is high demand for this equipment because of multiple economic activities in the area especially with respect to oil and gas that use the equipment in large numbers as the demand is relatively high. MRP and SCM were deduced to correlate strongly with IEMF. Out of the four non classical IMS identified for the study, vis-à-vis Just-in-Time (JIT), Material Requirements Planning (MRP), Lean System (Lean) and Supply Chain Management (SCM), only MRP and SCM were found to correlate strongly with IEMF. The method of Pearson product moment correlation analysis was used and the result indicated that MRP is followed by SCM and are the most significant IMS for IEMF. JIT and lean were not significant IMS for IEMF. MRP and SCM strategies have the capacity to effectively manage inventory items in manufacturing projects so as to satisfy the customized client's batch order quantity within schedule, budget cost and quality specifications.

RECOMMENDATIONS

In the light of the above, the following recommendations are proffered as follows:

(i) MRP is usually a computerized system. Updated computer software's should be installed to facilitate customers order processing, maintain accurate inventory accounts and better management of inventories for IEMF.

(ii) 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.

(iii) 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 IEMF.

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