Validation Of Developed Materials Requirement Planning (MRP) Integrated Flow System Model Of Ims For Piemf

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Abstract: Developed MRP as the Most Significant Inventory management Strategy that will correlate strongly with PIEMF. The result of the test case of MRP-based integrated flow system model as shown in table 6 Indicate that the model is effective and valid for PIEMF at 95% confidence interval with F-value = 3.121 and P-value (sig.) = 0.034. The model provides abstract representation and timely understanding of the subject matter and as a true indication of a situation of IMS for PIEMF. The flow system model will serve as a veritable decision support system of inventory management for PIEMF

Keywords: Inventory Management Strategy (IMS) Productivity Improvement in equipment Manufacturing Firms (PIEMF)

INTRODUCTION

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. The planning aspect involves looking ahead in terms of the determination in advance: what quality of items to order; and how often (periodicity) do we order for them to maintain the overall sources-store sink coordination in an economically efficient way? And how often (periodicity) do we order to maintain the overall stock coordination in an economically efficient way? The empirical evidence shows that each of the three equipment manufacturing firms maintains and keep raw materials inventories of not less than 551 or more units of different sizes, shapes, configurations and lead times. It is therefore important to develop a strategy that will be able to cope with the vast number of these inventories and dampen the uncertainties in the supply, stocking and processing so as to improve productivity in the equipment manufacturing firms. This will however help to satisfy the performance objectives of customized order quantity of the finished products requirements in manufacturing projects of the firms.

STATEMENT OF THE PROBLEM

Poor management of these raw materials inventory have tied capital down and prevent capital from being released for production thus, resulting to poor ROI and low productivity. For instance: Out of 3,200 hours scheduled for equipment manufacturing in the year 2014, only 2088 hours were utilized, 1012 hours of downtime was recorded representing 31.63 percent. A total of 636 hours (62.85%) out of 1012 hours of downtime was caused by inventory management related problems as shown on table 1. It could be on these premises that Ishola (2005) traces high cost of production to insufficient supply of raw materials, high cost of capital, poor utility supply, and operational delays. On the other hand, Ojo (1999) attributes low demand for finished products as a lingering constraint to manufacturing production. There have been deficiencies in the management of supplies of inventories, stocking both the raw materials and finish products as well as inventory accounting. Performance data with respect to manufacturing and inventory management of the manufacturing firm is shown on tables 1.1 and 1.2 respectively.

Table 1 Manufacturing Downtime Analysis in Dresser-Rand Nig. Ltd for the year 2014

S/N	Causes of Downtime	Downtime (Hours)	Percentage
1.	Due to equipment and machine breakdown	180	17.79
2.	Due to breakdown of generating set and repair	196	19.37
3.	Due to materials shortages and delay in supply	210	20.75
4.	Due to operational delays and congestion along the production	74	7.30
5.	line	128	12.65
6.	Due to congestion in warehouse, over production and delayed	62	6.13
7.	sales	50	4.94
8.	Due to inspection and testing of supplied materials	88	8.70
	Due to material order processing errors		
9.	Due to identification, sorting and classification of required component parts.	24	2.37
	Coupling and balancing the production line after congestion.		
	Total	**1,012**	**100.00**

Source: 2014 Annual report of manufacturing planning and control department of Dresser-Rand Nig. Ltd

Table 2: Marginal Costs of Materials and Inventory Management

S/N	Marginal Costs incurred due to deficiencies in materials/inventory management	Amount ($)
1.	Stock out cost /Rotor/Gas Seal / HP(B)bundle	7,000,000
2.	Determination and obsolescence of materials	1,000,000
3.	Mistakes and errors in processing order	500,000
4.	Marginal transportation cost due to small lot sizes purchases	500,000
5.	Products deterioration and depreciation	1,000,000
6.	Renting of additional warehouses for surplus materials supplies and over production including sundry expenses	2,000,000
	Total	12,000,000

Source:Extract from 2014 Annual report of equipment manufacturing accounting department of Dresser-Rand Nig. Ltd.

The multiplier effects of low productivity on the society due to ineffective inventory management include: manufacturing firms operating at low capacity, folding-up of some firms, laying off of workers, unemployment, high cost of products i.e. these equipment, insufficient procurement of equipment to the value chain and their resultant poor performance, low standard of living, and low gross domestic products etc. Similar primary field survey and investigations were carried out at Siemens and Nigeria Engineering Work Ltd with related results and findings.

OBJECTIVES OF THE STUDY

The aim of the study is to develop inventory management strategy that will be effectively employed to increase productivity in equipment manufacturing firms in order to satisfy Customized batch order quantity within Schedule, budgeted cost and quality specification, while the Specific objectives are:

- To develop an integrated decision support flow system model for productivity improvement in EMF, by combining the variables of the most significant IMS with production system and inventory management parameters.
- Test and Validate the developed Integrated decision support flow system Model for Productivity improvement in EMF's

RESEARCH QUESTIONS

- What is the most significant Inventory Management strategy that will influence Productivity?
- How could inventory management decision support system be developed for productivity improvement in EMFs?

RESEARCH HYPOTHESES

H_1 The effectiveness of inventory management strategy on the productivity improvement of EMF is significantly different.

H_2 The effectiveness of the developed flow Model of Inventory Management Strategy is not significantly different in decision support

REVIEW OF RELATED LITERATURES

Materials Requirement Planning (MRP)

MRP ensures effective scheduling of flow of material requirements and activities of manufacturing and product development projects, and therefore result to cost reduction and project success. It could be on this premise that Gaither (1990) postulates and opines that reduction in materials cost and cost savings could be through efficient material requirement planning (MRP), being one of the most efficient and effective ways of minimizing production costs. The author reinforces 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 purchases materials (Gaither 1990). The researcher therefore considered it necessary and infers that MRP could be used to propose and develop appropriate strategy for planning and controlling of the flow of materials, stock control, efficient production planning and control methods. Johnson and Mattsson (2002) in their study found that the most known and widely used materials planning methods are re-order point systems, run-out time planning, MRP, Kanban and order-based planning. The techniques used are not mutually exclusive and independent.

Supply Chain Management (SCM)

The primary objective of supply chain management is to reduce risks and uncertainties into supply chain, thereby positively affecting inventory levels, operation and production cycle time, processes and ultimately end user's service levels. The focus is on system optimization and enhancement of performance effectiveness. The various tools that are useful in system optimization are forecasting, aggregate planning, inventory systems and operations scheduling. A forecast is developed from the common database, which in turn becomes the input for aggregate planning. The aggregate plan sets the guidelines and constraints for the inventory plan and from this, requirement of workforce and equipment schedule are prepared. The need for supply chain management which the result of this study would address and according to Stevenson (2007) and Telsang (2010) are

i. The need to improve operation through procurement, distribution, and logistics, i.e. the supply chain.
ii. Increasing the level of outsourcing by buying goods or services instead of producing or providing them in-house. Time and cost are saved by increasing the level of outsourcing.
iii. Increasing transportation costs which need to be more carefully managed.
iv. Competitive pressures and this has expanded the physical length of supply chain.
v. Increasing importance of e-commerce
vi. Addressing the complexity of supply chains: supply chains are complex, they are dynamic, and they have many inherent uncertainties that can adversely affect the supply chain such as inaccurate forecasts, late deliveries, substandard quality materials, equipment breakdown and cancelled or changed order.
vii. The need to manage inventories because inventories play a major role in the success or failure of a supply chain, so it is important to coordinate inventories throughout a supply chain management.

For SCM to perform very well in EMF, the following elements need to be given attention:

i. **Customers**: The driving force; determining what products and/or services the customer want.

ii. **Forecasting**: Predicting the quantity and timing of customers demand.
iii. **Design**: Incorporating customers wants, manufacturability and time to market.
iv. **Processing**: Controlling quality, scheduling work and transformation activities.
v. Inventory: Meeting demand requirements while managing the cost of holding inventories.
vi. **Purchasing**: Evaluating potential suppliers, supporting the needs of operations on purchased goods and services.
vii. **Suppliers**: Monitoring supplier's quality; on-time delivery, and flexibility, maintaining supplier's relations.
viii. **Location**: Determining the location of facilities
ix. **Logistics**: Deciding how to best move and store materials and information. Benefits of effective supply chain management include: lower inventories, low cost, higher productivity, improve ability to respond to fluctuations in demand, shorter lead times, higher profits and greater customer loyalty.

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 common goal (goal sharing). This requires trust and willingness to cooperate to achieve the common goals. Co-ordination and information sharing are critical to the effective operation of a supply chain. Information exchange must be reciprocal: partners share forecasts and sales data, as well as information on inventory quantity and quality, impending shortages, breakdowns, delays and SCM could therefore be inferred to be a veritable strategy for PIEMF. Creating an effective supply chain requires linking the market, distribution channels, processing and suppliers for it to perform well and boost PIEMF. According to Stevenson (2007), the design of a supply chain should enable participants in the chain to achieve significant gains, hence giving them an incentives to cooperate, share forecasts, determine the status of order in real time, and access inventory data of partners in SCM.

Lean/Pull Inventory Management Strategy

Lean manufacturing thus produces goods with few people, little inventory and little waste. According to Telsang (2010), 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 encounter in EMF. In addition, the following difficulties in adapting lean technique as opined by Telsang (2010) could adduce reasons for results of the analysis indicating non-significant level for lean IMS. These are:

- Shortage of resources (especially in developing nation like Nigeria) that can inhibit the reengineering of process.
- Smooth flow is required throughout the supply chain (which may not be always possible because of some technical and socioeconomic problems in Nigeria).
- Natural calamities affect the efficiency of logistics
- Training and know how at each level of organization. The concept demands a fundamental change in corporate culture, understanding, cooperation, team work

Just in Time Inventory Management Strategy

JIT purchasing is a major component of JIT manufacturing system. According to Telsang (2010), 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. Ubani (2012) 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 for productivity improvement. Though is a popular IMS for Toyota manufacturing in Japan, it has been investigated for non-performance in PIEMF in River State of Nigeria. In a study done by Kolia (2011), in order to test inventory performance link using construction firms listed in Bursa Malaysia, it was found that there is a positive correlation between inventory turnover and capital intensity as a result of the nature of investments.

Factors Influencing Inventory Control

Holding inventory for a reasonable period though may be expensive, but sometimes it creates security that may give rise to price increase and the resultant effect will be high turnover and profitability. It requires competent inventory management to be able to make profit while holding stock (Datta 1998). The identified factors influencing inventory which will be creatively used in the formulation, methods and utilization of integrated system of IMS for productivity improvement in EMF are listed as follows:

i. Requirements
ii. Quantity in stock
iii. Procurement time or lead time
iv. Obsolescence
v. Profitability

A study by Fullerton *et al* (2003) provides empirical support on manufacturing firms that implement higher degrees of modern inventory management techniques should outperform competitors; it was found that a positive relationship exists between firm's profitability and the degree to which waste reducing production practices such as reduced set up times, preventive, maintenance programs, and uniform workloads are implemented. These findings indicate that manufacturing firms employing modern inventory management techniques are consistently more profitable than their counterparts. Another study suggesting a positive relationship between inventory management performances was Eroglu and Hofer (2011), which used the Empirical Leanness Indicator (ELI) as a measurement for inventory management. They argued that inventory leanness is the best inventory management tool. Lean production considers inventory as a form of waste that should be minimized and has become synonymous with good inventory management. Their study on USA manufacturing firms covering the period 2003 – 2008 found that leanness affects profit margins. According to Eroglu and Hofer (2011), firms that are leaner than the industry average generally see positive returns to leanness. They found that the effect of inventory leanness on firm performance is positive and generally non-linear. Their study also implies that the effect of inventory leanness is concave which is in line with inventory management theory that there is an optimal degree of inventory leanness beyond which the marginal effect of leanness on financial performance becomes negative. Lazaridis and Dimitrios (2005) highlighted the importance of firms keeping their inventory at an optimum level by analyzing the relationship between working capital management and corporate profitability and stressed that its mismanagement will lead to excessive tying up of capital at the expense of profitable operations. A similar study by Rehman (2006) empirical established a strong negative relationship between the inventory turnover in days and the profitability of firms. Sushma and Phubesh (2007) in their study of 23 Indian Consumer Electronics Industry firms established that businesses inventory management policies had a role to play in their profitability performance.

Method and Materials

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 administered to the staff and management of DRR, SIE and NEW firms and technical partners involved in inventory and production management of equipment manufacturing The sample size *n* was supposed to be determined from *N*, using Yaro Yamane formula:

$$n = \frac{N}{1 + Ne^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1.0$$

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 EMF are small due to their unique dexterity.

ANOVA model
Table 3

Source of Variation	Sum of Square	Degree of Freedom	Mean Sum of Square	F-ratio
Between groups	SSB	k-I	SSB/k-I = MSB	MSB
Within groups	SSE	n-k	SSE/n-k = MSE	MSE
Total	SST	n-I		

Source: Nworuh (2003)

Where SSB = Sum of square between group = $\sum \frac{I^2}{n} - \frac{T^2}{nk}$,
degree of freedom (df) = k-I

SST = Sum of square of total = $\sum_{i=j} \sum \frac{T^2}{nk} - \frac{T^2}{rk}$, df = n - I
Tj = number of observation in jth column, K = number of population samples or column
n = number of observation in each k, T = overall total number of nk observation.

The decision rule is that if F > $F\alpha$, reject the null hypothesis and accept the alternative hypothesis. However, a computer-based ANOVA software via SPSS was used and the results were interpreted and deduced with the t-value and power of test.

Data Analysis and Discussion

The result of the first stage of analysis provided the most significant IMS that strongly and positively correlated with PEMF, which is an indicator of productivity improvement. Second stage of analysis established the level of effectiveness of optimal IMS as obtained on the first stage on the selected three equipment manufacturing firms. The analytical tool used one-way Analysis of Variance (ANOVA) to obtain their levels of significance. Third stage tested the developed MRP based integrated flow system model of optimal IMS also with ANOVA for the validation of the model.

Questionnaire distribution and returns by EMF
Table 4

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

Source: Field Work 2017

Table 5 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**

Source: Field Work 2017

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 Productivity Improvement in Equipment Manufacturing Firms (PIEMF) 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 Relative Influence Index (RII) of the necessary requirement and factors affecting inventory management on the PIEMF were assessed.

Hypothesis One

$H0_1$: The level of correlation between MRP Inventory Management Strategy and PIEMF is not significant
HA_1: The level of correlation between Inventory Management Strategy and PIEMF is significant

Summary of paired sample Pearson Product Moment Correlation Analysis results with four IMS in the three EMFs

Table 6

		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 data set for Ho_2 for IMS_2 is shown on table 6, also, the results of pair wise correlation analysis using Pearson product moment method are shown on above table. The result 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 PIEMF when employed in manufacturing projects. The level of PIEMF depends strongly on the performance of MRP. MRP therefore, need special attention, monitoring and control in order to impacts positive on the PIEMF.

Requirements for Effective Inventory Management, according to Stevenson (2007) are:

i. A system to keep track of inventory on hand and on order (TR)
ii. A reliable forecast of demand that include an indication of possible forecast error (FR)
iii. Knowledge of lead time variability (LT)
iv. Reasonable estimate of inventory holding costs, order costs, and shortage (ES)
v. A classification system for inventory items (CS).

Data collection for investigation of Relative Influence Index (RII) from the three EMF on the PIEMF. The weighed scales are as follows: Very High (VH) = 5 points, High (H) = 4 points, Average (AV) = 3 points, Low (L) = 2 points, Very Low (VL) = 1 point.

The total number of respondents from the three EMF = 112

Table 7: Data set distribution for RII of the requirements for effective inventory management on the PIEMF.

		Frequency of responses					
	Requirements for effective inventory management	VH	H	AV	L	VL	Total
1.	A system to keep track of inventory on hand and on order (TR)	30	36	33	6	7	112
2.	A reliable forecast of demand that include an indication of possible forecast error (FR)	20	16	63	4	9	112
3.	Knowledge of lead time variability (LT)	50	52	3	4	3	112
4.	Reasonable estimate of inventory holding costs, ordering costs and shortage costs (ES)	65	44	3	0	0	112
5.	A classification system for inventory items (CS)	55	44	6	4	3	112
	Total	220	192	108	18	22	560

Source: Field Work 2017

Table 8 Data set distribution for RII of influence of the factors affecting inventory management on the PIEMF

		Frequency of responses					
	Factors affecting inventory management	VH	H	AV	L	VL	Total
1	Procurement order lead time (POL)	15	12	33	46	6	112
2	Requirements (REQ)	60	40	9	2	1	112
3	Profitability (PRO)	70	36	3	2	1	112
4	Obsolescence (OBS)	5	8	21	42	36	112
5	Quantity in stock (QIS)	55	44	9	4	0	112
	Total	205	140	75	96	44	560

Source: Field Work 2017

Table 9 Analysis of levels of influence of necessary requirements of effective inventory management on the PIEMF

	Requirements	VH 5 %	H 4 %	AV 3 %	L 2 V	VL 1 %	TR	II	Rem	RI	Rank
1	TR	26.79	32.14	29.46	5.36	6.25	112	3.76	A/AV	0.19	4th
2	FR	17.86	14.29	56.25	3.57	8.04	112	3.30	A/AV	0.16	5th
3	LT	44.64	46.43	2.68	3.57	2.68	112	4.29	H	0.21	2nd
4	ES	58.03	39.29	2.68	0	0	112	4.55	H	0.23	1st
5	CS	49.11	39.29	5.36	3.57	2.68	112	4.27	H	0.21	2nd
	Total							20.17		1.00	

Source: Field Work 2017

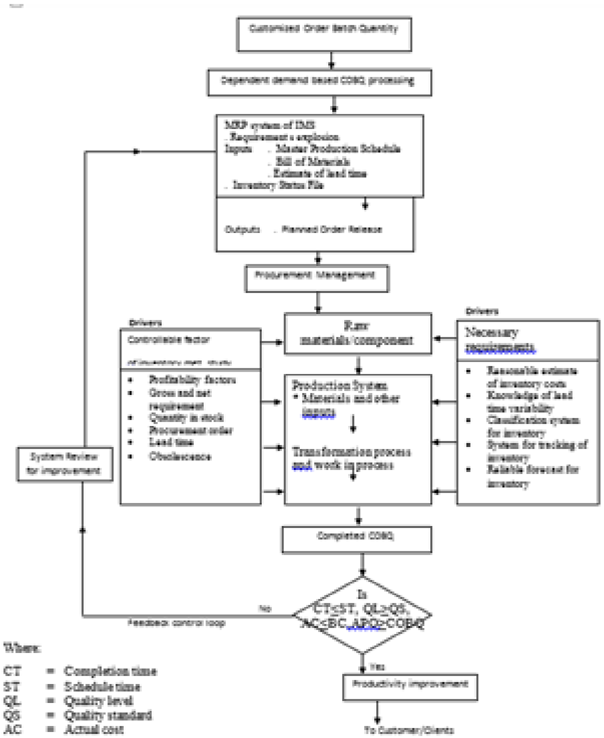
Table 10 Analysis of levels of influence of factors affecting inventory management on the PIEMF

	Factors	VH 5 %	H 4 %	AV 3 %	L 2 V	VL 1 %	TR	II	Rem	RI	Rank
1	POL	13.39	10.71	29.07	41.07	5.36	112	2.82	B/AV	0.15	4th
2	REQ	53.57	15.71	8.04	1.79	0.89	112	4.52	H	0.24	2nd
3	PRO	62.50	32.14	2.68	1.79	0.89	112	4.65	H	0.25	1st
4	OBS	4.46	7.14	18.75	37.50	32.14	112	2.18	B/AV	0.12	5th
5	QIS	49.11	39.29	8.04	3.57	0	112	4.33	H	0.23	3rd
	Total							18.50			

Source: Field Work 2017

Development of Integrated System of Optimal Inventory Management Strategy

The result of hypotheses testing with Pearson product moment correlation statistics indicated that MRP (IMS_2) is the optimal or most favourable IMS for PIEMF. MRP was therefore used to develop an integrated flow system model of IMS for PIEMF by considering the variables and parameters in MRP system, inventory management and production system. The integrated system model as shown in fig 1 below conveys the abstract view and logical steps for applying MRP for PIEMF



Where:
CT = Completion time
ST = Schedule time
QL = Quality level
QS = Quality standard
AC = Actual cost
BC = Budgeted cost
APQ = Actual product quantity
COBQ = Customized order batch quantity

Fig. 1
Integrated System of Optimal IMS for productivity improvement based on MRP

Test and Validation of MRP-Based Integrated Flow System Model for PIEMF

Test Case: "The developed MRP-based integrated flow system model for optimal IMS is an effective decision support system for PIEMF when applied

Table: 4.26 Data set for testing and validation of newly developed MRP-based integrated flow system model for PIEMF

Hypothesis Two
The effectiveness of the developed flow Model of Inventory Management Strategy is not significantly different

HA_2: The level of correlation between developed MRP Model of Inventory Management Strategy and PIEMF is significantly different

Data Analysis and Discussion

MRP-Based Integrated System of Optimal IMS for Productivity Improvement in Equipment Manufacturing Firms
The MRP-based integrated flow system model shows the flow of materials, energy, and information that bind the elements of the equipment manufacturing system and help explain its behaviour. The relationship between and among the elements is based on an orderly flow of logic. The flow model could be used to abstract a real world system in the model form to conform to specific values as basis for determining PIEMF and to relate it back to the real world of EMFs operations as a control technique. Table11 shows the descriptive statistics of the result of the test case of MRP-based integrated flow system model as shown indicate the model effectiveness and valid for PIEMF at 95% confidence interval with F-value = 3.121 and P-value (sig.) = 0.034 , as validated by the Three EMFS. EMFs receives the Customized Order Batch Quantity (COBQ) with time and cost frames, quantity and quality specifications. The information flows to order processing and cost accounting departments of the EMFs and in collaboration with technical experts, works out quantity and quality of dependent demand items to satisfy the COBQ. The information is then transferred to MRP system to prepare or determine the requirement explosion, master production schedule, bill of materials, estimate of lead time and inventory status file as MRP inputs. The MRP system will process this information to generate MRP outputs in the form of planned order release, planned order schedule and inventory transaction details. The procurement management unit will take actions in the supply of requisite cost effective materials based on MRP inputs and outputs requirements that will satisfy the budgeted cost, quantity and quality specifications. Raw materials and components parts for EMF that will meet the predetermined objectives will be supplied into the production systems. The production systems transforms the materials and components parts into finished equipment products using the predetermined energy units, capital, labour and time. There are drivers in the form of controllable factors and necessary requirements for effective inventory management toward accomplishing the COBQ. The completed COBQ, through the help of manufacturing planning and control functions evaluates the performance of EMF in terms of budgeted cost, scheduled time (cycle time and throughput), quality standards, demand COBQ and energy consumption. The actual outcome that deviate from the planned outcomes after comparison will necessitate systems review for improvement. However, if the EMFs outputs meet or exceed (less in terms of time) the targeted parameters, there is productivity improvement. The conception and innovative logic of the developed MRP-based integrated flow system model of optimal IMS will definitely enhance productivity when creatively employed to EMF. It is opined that the result obtained from the model testing will be consist

FINDINGS
The result of the test case of MRP-based integrated flow system model as shown in table 11 indicate the model is effective and valid for PIEMF at 95% confidence interval with F-value = 3.121 and P-value (sig.) = 0.034. The model could therefore be used for decision support system for PIEMF. The result of the analysis carried out with Pearson product moment correlation analysis indicated that MRP is the optimal IMS for PIEMF. The variables of inventory management, production system and MRP were creatively employed in the development of schematic integrated flow system model for PIEMF. The model provides abstract view and quick understanding of the subject matter and as a representation of a situation of IMS for PIEMF. The flow system model will serve as a veritable decision support system of inventory management for PIEMF.

CONCLUSION
The study examined and delved into IMS for PIEMF. The non-classical inventory management strategies were identified and subjected to Pearson product moment correlation analysis. MRP was deduced to correlate strongly with PIEMF. The study developed and designed an integrated flow system model with MRP (being the most favourable IMS) as an abstract representation of reality or situation in EMF. When MRP was subjected to validity test using ANOVA, the results indicated that there is significant difference in their effectiveness when applied to the three EMF. The results of the study have been discussed in details.

RECOMMENDATION
Inventory management can be a competitive advantage by effectively matching supplies of raw materials, work-in-process and goods with demands. EMF could achieve enhanced performance by creatively employing MRP as IMS strategy, and have major influence on competitiveness through effective delivery of customized batch quantity. 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 PIEMF.
ii. 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.
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 PIEMF.

iv. Scheduled productions of items should be integrated into the MRP logic while taking into considerations production and materials order lead times respectively.

v. The developed and designed integrated system of flow model for decision support in PIEMF should be reviewed and evaluated periodically for adjustment continuous and improvement when necessary.

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