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Development of a Stock Control and Management System based on Just-in-Time Technique

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***Abstract*—The existing inventory control and management systems are bedevilled with issues such as lack of implementation, non-generalization, susceptibility to subjectivity, measurement error, and low reliability, among others. This paper presents a Just-in-Time platform that could overcome some of these inventory management issues. The platform comprises customer, demand planning, supply and production control interfaces. The customer interface provides the basis of interaction between the user and the system and was designed with friendliness, efficiency and enjoyable tendencies while facilitating a seamless operation. The demand planning interface comprises sales and demand planning components for online receipt and processing of sales orders and verifications of customers' personal information and payment details. The *supplier interface is required for receipt of* manufacturing orders and supply by the production schedule. The production planning control interface handles the production items, time, and quantities and so on. It was designed to provide capacity for speedy production to meet agreed or projected demand. The experimental study of the model on the ordering management of two production companies in Lagos, Nigeria confirmed its positive impact on the production cycle, turnover and holding cost with its 95% fulfilment of orders compared to 73% recorded for the non-JIT ordering. It was also revealed that the use of Just-in-Time (JIT) led to a 59.34% gain in profit and 12.73% reduction in expenditure.**

***Keywords*— Inventory management, Joint-in-Stock, Production cycle, Control interface, Goodmama**

I. INTRODUCTION

Inventory is an essential component of any manufacturing or sale process and it is primarily classified into raw materials, work in progress and finished goods (Mishra and Salunkhe, 2018). Inventory keeping is good for stabilizing the production wheels, ensuring the distribution system is intact and guaranteeing the sustainability of the market. It plays a major role in the organization of production activities, maintenance of plants and machinery, lubrication and proliferation of the production and distribution systems, and other operational requirements (Afolabi *et al.,* 2017*)*. In the manufacturing aspect, inventory is a vital part of current assets as huge funds are committed to ensuring a smooth flow of production and meeting consumer demand. Poor inventory could result in non-accountability of stocks, inaccurate checks and balances and loss of revenue. The process of control and management of inventory is therefore a very germane element in the success or failure of any business. Little inventory level often results in stock-out with the harmful effect of disrupting the production distribution cycle while too much inventory level will tie down the resources of a company. It is therefore implied that poor or inadequate inventory management poses a threat of a serious challenge to the productive capacity of a manufacturing organization (Iwasokun and Alimi, 2022). A sound inventory management system leads to successful business operations and supply chains. The scope of inventory management entails stock up of lead time, forecasting of inventory, physical stock, space availability for inventory, quality management and so on (Jesvin and Pillai, 2019). Inventory management is vital for reducing costs or proliferating profits while satisfying customers' demands by guaranteeing that balanced items of stock are sustained at the right quality, quantity, time and place. At different locations within an organization or within multiple locations of a supply chain, good inventory management is helpful for protection against low levels of materials or goods. Business owners and managers often placed a premium on warehousing and stockrooms full of products and raw materials ready to be moved into production lines with less emphasis on the cost of carrying and handling inventory as well as the cost of damage, spoilage, obsolescence and spacing.

Inventory needs to be managed efficiently for the smooth running of the business, fulfilling an expected demand, avoiding a stock-out situation, seeking protection from price increases shortly and smooth distribution cycle (Mishra and Salunkhe, 2018). An efficient inventory management system contributes to the unified functioning of all the various business components. Inventory control is a policy designed to achieve accurate measures and the exact worth of raw resources at precise places. It is a system for disciplined control of a firm's investment in stock and encompasses the tracking and observing of stock levels, forecasting future demand and deciding when and how many to order (Ugwu, 2012). Inventory management techniques are extremely important for business operations since the success and cost reduction of the firm's expenditure guarantee improved supply chain performance and knowledge to the employees. The techniques include Economic Order Quantity (EOQ), Vendor-Managed Inventory (VMI) and Just in Time (JIT) (Afolabi *et al,* 2017; Ogbo, 2011; Afolabi *et al.,* 2017 & Salahudeen and Abraham, 2018). The JIT inventory model is used to restock for organizations only when required. The model tries to do away with surplus inventory and its connected costs (Afolabi *et al.,* 2017). A crucial requirement for JIT is safeguarding against delayed delivery which can result in costly and irretrievable business losses warranted by any deferral in inventory delivery. The technique is evolving and aims to improve return on investment by reducing in-process inventory and associated carrying costs. It is also associated with bringing about increment in quality, profitability, and effectiveness, enhanced correspondence, and abatements in expenses and squanders (Atnafu and Balda, 2018; Afolabi *et al*., 2017; Atnafu and Balda, 2018; Hutchins, 1999).

The existing JIT and other inventory control and management techniques are susceptible to inadequate data-driven approach, geographical and cultural limitations, and lack of implementation and consideration for generalized, large and medium-scale sectors. They also experience subjective evaluation which increases measurement error due to relative low reliability. These issues create a research gap that the current research was set to fill. An attempt was made to integrate the Just-In-Time (JIT) technique for stock and ordering management in manufacturing environments as a way of curtailing wastes, achieving the falling level of in-process inventories of purchased products and finished goods, running production lines at optimal speeds with minimal downtime and achieving high-quality products with good operational speed.

II. RELATED WORKS

Ugwu (2012) examined the essence of effective inventory control and management in manufacturing companies. The focus was on determining the extent of damages caused by ineffective inventory management as well as examining the level of losses caused by inadequate inventory of finished goods. It was revealed that a poor inventory model resulted in low productivity as well as other management issues. The small sample population however subjects the reliability of the findings to questioning. Salahudeen and Abraham (2018) presented the effect of inventory management systems on operational performance in manufacturing firms. An attempt was made to identify and enlighten management on the proper use of inventories and how inventory management system affects operational performance in manufacturing firms. Emphasis was placed on establishing the effect of inventory management systems on operational performance, determining the extent of damages caused by poor inventory management systems on an organization's operation, ascertaining the effect incompatibility of organizational policy on inventory management and assessing the influence of inventory management on production cost and profitability. The study established a significant relationship between inventory management systems and organizational performance and profit margin but was limited in scope.

Atnafu and Balda (2018) presented the impact of inventory management practices on firms' competitiveness and organizational performance. The impact of inventory management practice on firms' attractiveness and organizational performance was empirically examined based on micro and small enterprises' competitiveness and performance. It was revealed that higher levels of inventory management practice can lead to an enhanced competitive advantage and improved organizational performance in addition to competitive advantage, though it only presents MSEs' manufacturing sub-sector points of view. Ribeiro and Machado (2014) presented a review of empirical studies on JIT. The review sought to present knowledge on the main characteristics of JIT and to identify its main benefits. The key features and benefits of JIT reported in theory were compared with the practice reported by companies in existing empirical studies. This was followed by the documental analysis of the fraction of use and the importance of JIT across countries. The review established a clear idea of the main benefits and key features of JIT as well as its use as an entire philosophy and, more specifically, in each stage of implementation. It was also reported that most of the studies analyzed were constrained to the same manufacturing companies and conducted in the same countries which constrained it to geographical and cultural analysis in addition to some obsolete sources.

Mankazana and Mukwakungu (2018) presented the impact of Just-in-Time (JIT) on the inventory management system and the supplier's overall performance of South Africa's bed mattresses. The research focused on investigating the positive and negative effects of the JIT system on inventory management. The investigation was based on structured questionnaires and descriptive statistics were used to summarize the data collected by comparing two companies producing the same products with different suppliers, and with different inventory management systems. The research established guidelines on how to implement a JIT inventory system, in such a way that inventory is handled correctly and the performance of the organization improves as well as knowledge of the important personnel and the role they play in the implementation of JIT in organizations. The scope of the study is however limited as it focused only on two manufacturing companies. The review of genetic algorithms for solving multi-product JIT sequencing problems with set-ups was presented by Mcmullen *et al*., (2000). The review attempted to solve the Just-in-Time (JIT) sequencing problem for multiple product scenarios when set-ups between products are required. Attempts were made to set up a minimization step of production activities, show minimization of usage rate that is, the company's ability to keep the schedule level of raw material and determine the sequence that minimizes a composite function of both set-ups and usage rate. Efforts were also directed at knowing the sequence that minimizes a composite function of both set-ups and usage rates in addition to the sequence that minimizes the composite function. The research established genetic algorithms as a formidable solution to the multi-product JIT sequencing problem with set-ups as well as its desirability over simulated annealing and Tabu search methods. The scope of the study is however limited as it was conducted as a model and not practically applied. The implication of the Just-In-Time System of Toyota Automobile Company was presented by Sahil (2017). The research presented the need to understand and analyze the various implications that are faced by the Toyota Motor Corporation Production system based on the theory of Just-In-Time. It also looked into the analysis of the different scenarios like natural and unforeseen disasters involving efficiency in Toyota's system inventory control. Toyota's Production System and its core elements of the Just-in-Time System were analyzed through past experiences. The research demonstrated a better approach to JIT philosophy and proper application of the Kankan and Jidoka system in finding defective products and solving the relevant problem in addition to its confirmation of JIT as one of the very essential ways of Toyota reaching new heights. The study however failed to pay attention to shortages from suppliers which could have a consequential effect on production coupled with paying no attention to other manufacturing firms.

Bon and Garai (2011) presented a JIT approach in inventory management with an attempt made to know how the implementation of JIT would impact inventories in electronics component industries, especially at the parts producing stamping of Fine Chemical and Materials (FCM). The research involved pre and post-application of JIT during production, the use of JIT to reduce the standard time required for setup and winding process as well as packing and delivery to the warehouse. The study established how JIT influenced demand, inventory space requirements, and building long-term relationships between suppliers. However, it only focused on one factory, and hence limited in scope. Kilic and Erkayman (2021) presented a simulation approach for the transition to the JIT production system. An attempt was made to present a comprehensive real-time, data-driven approach to detect the bottlenecks and work-in-process (WIP) inventory using real-time data from machines and personnel. Observation-based data collection method was used on machines/personnel at different times and shifts followed by verification and validation processes. The validation processes addressed bottlenecks which include improper conveyor layout, imbalance work-in-progress inventory in production lines and insufficient machine capacities. The research established a relationship between the number of finished products and machine usage rate as well as between work-in-process (WIP) inventory and utilization of personnel and machines. However, it was conducted only at one factory which renders its data-driven approach inadequate. The impact of the JIT inventory system on efficiency, quality and flexibility among the manufacturing sector, and small and medium enterprises (SMEs) in South Africa was presented by Mazanai (2012). The impact of the application of Just-In-Time (JIT) inventory management system in the manufacturing sector SMEs was investigated alongside the factors which impede the application of the JIT inventory management approach among SMEs in the manufacturing sector. The study was based on the perspective of a formal research design through the definition of the study population, the incorporation of suitable measuring instruments and reliable techniques for data analysis. The study established how manufacturing sector SMEs benefited significantly in terms of improved quality of products, increased operational cost cuts and increased flexibility from the application of JIT inventory management principles. Further analysis also justified some inconsistencies on the part of the obtained results.

The summaries of the limitations of the models or platforms reported in (Mankazana and Mukwakungu, 2018; Mcmullen *et al*., 2000; Salahudeen 2018; Atnafu and Balda 2018, Sahil, 2017; Bon and Garai 2011 and Kilic and Erkayman 2021) include inadequate data-driven approach, limitation in geographical, cultural analysis and scope, failure to implement, lack of consideration for generalized, large and medium scale sectors and focus on subjective evaluation which increases measurement error due to relative low reliability. This research was therefore motivated by the need to overcome inventory management challenges as well as the failures and limitations of the previous research works through the integration of Just-In-Time (JIT) in Stock and ordering management systems in manufacturing environments as a way of reducing wastes, reducing the level of in-process inventories purchased products and finished goods, running production lines at optimal speeds with minimal downtime and creates good quality products while operating at high speed.

III. SYSTEM DESIGN

Fig. 1 presents the architecture of a new JIT system for stock control and management. The system provides an overall framework in which the various activities, people, and issues that are related to the production and distribution of goods and services either directly or otherwise are organized. Essentially, the new system defines the nature of the relationship between the various functional units in an organization and addresses issues relating to structure, systems, procedures and people. It comprises four interfaces; namely customer interface, control interface, supplier interface and production control interface whose details are provided below.

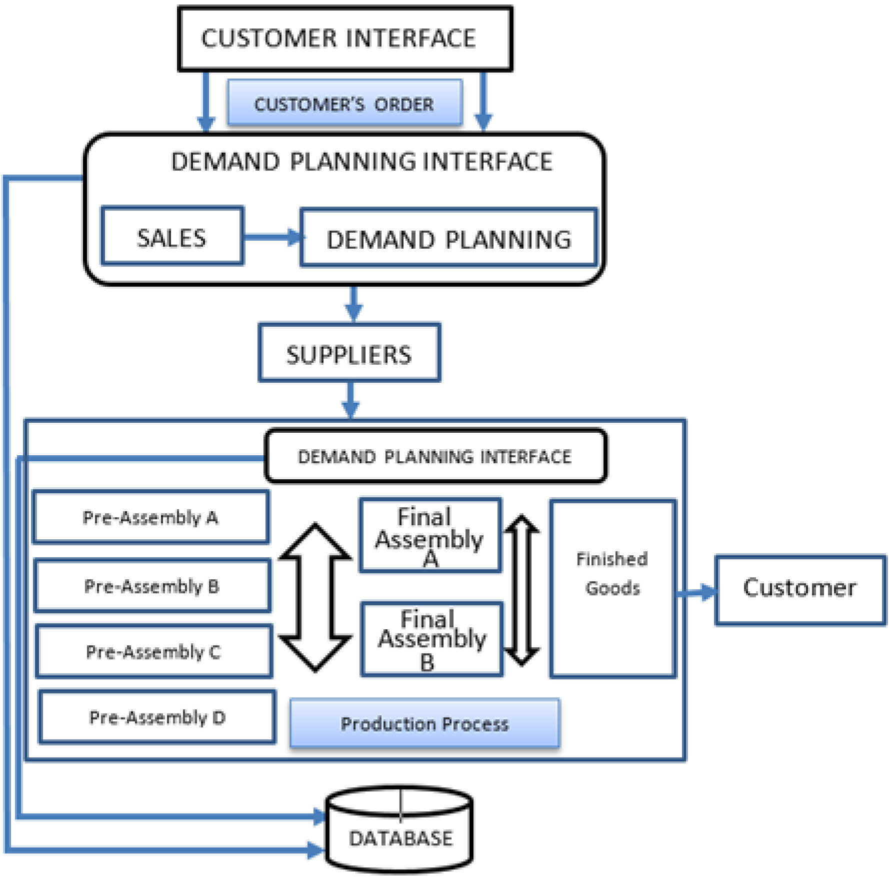

Fig. 1. The proposed Just-in-Time Stock and ordering management

Customer Interface

This is the interface through which the user and the system will interact. It will serve as a visual part as well as the medium through which input will be fed and output will be displayed to the user. The interface is designed to provide a friendly, efficient and enjoyable experience to users while facilitating a seamless operation.

Demand Planning Interface

This interface comprises sales and demand planning components. The sales interface serves as the intermediary between the customers and the manufacturer. It is used for online receipt and processing of sales orders and verifications of customers' personal information and payment details. The interface will provide phone or email links for customers to answer queries and obtain missing information. It is also responsible for the maintenance and update of sales and customer records, directing feedback from customers to relevant departments and compilation of monthly sales reports. It will also be used to achieve customer satisfaction during purchase. The Demand Planning interface is a supply chain management process of forecasting and it is involved with analyzing capacity and resource requirements before the manufacturing process and controlling the raw materials in the inventory needed for producing finished goods. It will be used to review sales forecasts and customer demand and schedule production batches based on inventory levels and production times. It is the stage at which materials requirements calculation takes place alongside the generation of the summary of required materials needed for production and the purchase requirements (PR) list. The Purchase Orders (PO) are also generated with the lot size which is based on the quantity *scheduled.*

Suppliers Interface

Through this interface, the suppliers receive the manufacturing order and the materials needed to meet the customer's order. *The demands will be met* by the production schedule.

Production Planning Control Interface

Different production processes are integrated at this interface. Production planning involves items to produce, the production time, the quantity to produce and so on. The interface is concerned with providing capacity for production to meet agreed or projected demand, ensuring speedy and location-based accessibility of supplies and constituents, delivery of a stable movement of effort via every unit and provision of a well-adjusted synergy across all units concerned with the production operation. It also promotes proper management by ensuring the availability of adequate manufacturing instructions and the prevention of failure or delays through adequate supervision and communication. Adequate planning is very germane to the success of the inventory process and it involves generating a workflow to satisfy customers with a good and sustainable profit margin. Its specifics vary from company to company and rely on the implementation of certain basic and control functions. The number of workers needed (w) is calculated from the equation:

$$w = \frac{d}{\delta * \gamma} \tag{1}$$

d is the demand per day and δ is the number of days in a month and γ is the number of workers per day. The production rate (p) is derived from:

$$p = \frac{s * t}{c} \tag{2}$$

s is the number of shift hours, t is the unit time and c is the cycle time of the product.
The hiring cost (h) is based on the formula:

$$p = h * w \tag{3}$$

h is the hiring cost per worker and w is the number of hired workers. The unit produced, p is derived from:

$$p = u * \alpha \tag{4}$$

u is the unit per worker and α is the unit per worker.

$$\alpha = p * y \tag{5}$$

y is the number of days. The net inventory (n) and the total cost (t) are calculated as follows:

$$n = p - \sigma \tag{6}$$

σ is the total demand.

The cycle time of a product is C_t minutes, the working shift is two shifts per day and the working hour is W_h hours per day. The working days for each week are W_d days with s shifts for each day and x working hours per shift. The process duration for delivering one item is γ hours. The production rate is x unit worker per day while the monthly workers needed, φ is:

$$\varphi = \frac{\omega}{12\gamma * p} \tag{7}$$

The unit produced is calculated from:

$$\nabla = \alpha * w \tag{8}$$

The *Capacity Hour*, C_h is the process that involves the determination of the potential of a unit to perform a specific task within a set time framework and it is derived as follows:

$$C_h = (W_h * w * y) + O_h \tag{9}$$

O_h is the overtime hours. The available capacity is derived from the product of the number of workers, working hours and the number of days while the regular available capacity is obtained from the product of production rate, monthly working days and the number of workers. The cumulative inventory is the difference between the cumulative production and cumulative demand. Net inventory is the sum of the previous month inventory and the unit produced less than the required demand. The labour cost is determined by multiplying labour cost/hour, days and workers used.

Production activities and inventory planning are performed by utilizing resources effectively and carrying out production and inventory control by making adjustments between the plan that has been made and the daily production activities. They create production schedules according to the planned time, route and quantity and speed up order fulfilment, planning of optimization of machine productivity and optimising inventory management. The computation of the customer's demand is based on the computation of the proportion of the raw materials needed for production and multiplying it with its corresponding gram.

Database Design

The design of the backend system is based on a highly organized collection along with appropriate tools and applications that facilitate processing and access to data. The design comprises a collection of schemas, tables, queries, reports, views and others to provide a repository where details of required goods, records of sales transactions and the status of orders are maintained. It gives structure to the procedures, techniques, tools and documentation for supporting and facilitating the process. It involves the identification of entity and relationship types. Identification of entities involves the reorganization of user-interested objects while identifying relationship types involved the establishment of the possible views of the backend and the relationship between them.

As seen in Figure 2, the first step is to place an order by the customer. The order reaches the planning department for entry into the system. The demand planning instantly receives the necessary information as the order is automatically converted into a manufacturing order. The forecast is based on a production strategy designed to meet demand with precision and timeliness while reducing waste and all irrelevant costs associated with setting up excess goods. Precise demand prediction is hence a criterion for the production model. The information is retrieved based on the prediction for the supplies which are by the purchase order and the quantity stated. This is followed by verification to see if it meets up with the standard procedures for quality production. The raw materials are processed and converted into finished products for onward delivery to customers. The system was designed to trim the business, operations, and resources of the unwanted by providing a centralized data system with effortless and accurate communication between departments.

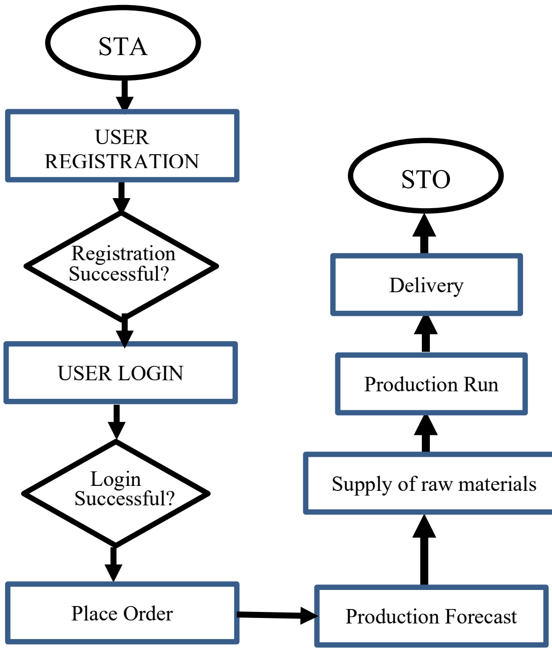

Fig. 2. Flowchart of the proposed JIT ordering system

IV. EXPERIMENTAL STUDY

The experimental study of the proposed JIT technique was on a 1GB RAM and 100GB HDD personal computer with Windows 10 operating system, Xampserver and Chrome Web Browser with Internet access. The experimental data include the criteria derived from customers' requirements in ordering which present detailed information about inventory items and transactions. Due to variations in the manufacturing process, there are differences in customer requirements. Also, in line with the expectations of companies, appropriate approaches were used to eliminate the stocks with zero turnovers and prevent the related problems from reoccurring. To reduce inventory costs and improve efficiency, the most suitable purchasing strategies were designed in line with the different groups of items. The study is based on the ordering management of two companies; namely Eko Supreme Resources Limited and Natural Prime Resources Limited where four classes of criteria were discovered for potential raw materials supplied before the implementation of JIT as the deciding factors. Eko Supreme Resources Limited and Natural Prime Resources Limited are located in Agbara, Ogun State, Nigeria and are denoted as Company A and Company B respectively. These companies are principally engaged in the manufacturing and sales of detergents. Eko Supreme manufactures various variants of Goodmama such as Goodmama Lemon, Goodmama Flora, Goodmama Ankara and Goodmama Diamond having different stock keeping unit (SKU) while Natural Prime Resources Nigeria Limited produce detergents such as Soklin, Soklin Ultra, Soklin Protect and boom with different SKU. Company A has a total of 15 raw material items with 4 attributes with corresponding classes. The classes shown in Table 1 were deduced from the interviews of personnel from the related departments in the two manufacturing companies. The interviews focused on the classifications of raw materials.

TABLE 1. Different Raw Materials for Goodmama with their classes

Solid Raw Materials	Class A
Liquid Raw Materials	Class B
Post-Blending Raw Materials	Class C
Semi-Finished Goods Liquid Raw Materials	Class D

There are three (3) materials in Class A denoted with A1, A2 and A3 respectively. Class B consists of three (3) items represented as B1, B2 and B3 respectively. Class C consists of seven (7) materials denoted as C1, C2, C3, C4, C5, C6 and C7 respectively. Class D materials are subdivided into materials D1 and material D2. D1 was based on the mixture of 25% of item B1 with 75% of water while D2 was derived from a combination of item B2 with material D2 in the same proportion. These materials came in different proportions depending on the item to be produced. Sales target is the determinant factor for production, that is, market demands determine the production target that must be achievable. The production was planned for 232,285.69 kg of different variants of Goodmama in the proportion shown in Table 2.

TABLE 2. Different Goodmama raw materials and their proportions

Category	Proportion	Quantity Required
Solid Raw Materials	43.65	101,380.92
Liquid Raw Materials	28.84	066,983.41
Post-Blending Raw Materials	02.90	006,735.50
Semi-Finished Goods Liquid Raw Materials	24.61	057,158.86

Goodmama compositions were the same for different variants on the ground of their respective perfumes required. Company B has a total of 18 raw materials and 4 attributes with the corresponding classes as shown in Table 1. The subdivision of the classes followed the same pattern as Company A and in different proportions depending on the item being produced. The production planned for 232,285.69 kg of different variants of Soklin came in the proportion shown in Table 3.

After the composition of different variants of Goodmama and Soklin, the finished products were packaged according to their respective grammages and weights as shown in Table 4.

TABLE 3. Different Soklin Raw Materials with their proportion

Category	Proportion	Quantity Required
Solid Raw Materials	44.60	103,587.38
Liquid Raw Materials	39.49	091,718.96
Post-Blending Raw Materials	2.87	006,665.82
Semi-Finished Goods Liquid Raw Materials	13.04	030,285.53

TABLE 4. Grammage and their corresponding weights

Grammage	Weight (kg)	Number of Cartons
22	3.69	62,943
80	4.00	58,065
90	4.50	51,613
170	4.42	52,547
450	5.40	43,011
850	5.10	45,541
935	5.61	41,401

System Performance

Table 5 shows the figures for the number of submitted and fulfilled orders for the proposed JIT system and the conventional practices in the two companies. The higher figures for JIT revealed its potential to improve the ordering system in the two companies. The comparative analysis of profit and expenditure (in naira) using the proposed JIT system and the conventional practice is presented in Table 6. A statistically significant positive impact of the use of the JIT technique over the conventional method is observed. The figures also established that having inventory around the manufacturing space can positively impact the production cycle and the turnover as well as increase the holding cost.

TABLE 5. Submitted and fulfilled orders for JIT and conventional methods

Inventory Method	Volume of order	% Fulfilled
Use of JIT (June 2023)	20000	95
Non-use of JIT (May 2023)	17800	73

TABLE 6. Comparative analysis of profit and expenditure in naira with JIT and conventional methods

Inventory Method	Conventional method	JIT method	% Gain
Profit	080,530,000.00	128,320,000.00	59.34
Expenditure	375,470,000.00	327,680,000.00	12.73

These figures are premised on the fact that the JIT method offered vast improvements over the conventional methods in terms of ease of access and organizational and structural flexibility coupled with significantly reduced processing time. It can be deduced that applying the JIT inventory management principles significantly assists in surviving the harsh realities of the modern business economy experienced in conventional methods.

System Appraisal

The performance of the JIT system was appraised using desired features/functionalities based on data collected from the online survey of the users. The participants included production staff, admin staff, interns and customers of Eko Supreme Resources and Natural Prime Resources Nigeria Limited. The metrics for the appraisal include reliability, speed; security, effectiveness, usability; adaptability, user interface and experience, and ease of use. The participants' responses were based on a scale of five, four, three, two and one for excellent, good, average, fair and poor respectively. Table 6 presents the summary of the ratings by the respondents.

TABLE 6. Summary of users' responses to the online appraisal of the JIT system

S/No.	Questions	Excellent	Good	Average	Fair	Poor
1.	How satisfied are you with the JIT System?	36 (45%)	37 (46.3%)	07 (8.6%)	01 (1.2%)	0 (0%)
2	How easy is it to use the system?	41 (51.5%)	31 (39.2%)	06 (7.2%)	01 (1.3%)	0 (0%)
3	How fast is the JIT system?	40 (50%)	32 (40%)	07 (8.8%)	01 (1.2%)	0 (0%)
4	How would you rate the system's ability for production run?	35 (43.8%)	34 (42.5%)	09 (11.3%)	02 (2.5%)	0 (0%)
5	How friendly is the customer's interface?	45 (56.3%)	24 (30%)	10 (12.5%	01 (1.2%)	0 (0%)
6	How relevant is the ordering system to your desired ordering requirements?	39 (47.6%)	32 (39%)	10 (12.2%)	01 (1.2%)	0 (0%)
7	How relevant is the JIT system to your desired inventory and stock management?	38 (47.5%)	32 (40%)	09 (11.3%)	01 (1.2%)	0 (0%)
8	How would you rate the effectiveness of the system for inventory management?	33 (40.7%)	37 (45.7%)	10 (12.3%)	01 (1.2%)	0 (0%)
9	How reasonable is the JIT system?	32 (40%)	32 (40%)	15 (18.8%)	01 (1.2%)	0 (0%)
10	How would you rate the quality of your work with the JIT system?	36 (45%)	31 (38.8%)	12 (15%)	01 (1.2%)	0 (0%)

More than 75% of the participants judged the proposed system very easy to understand and also gave an 'Excellent' or "Good" rating. 8.6%, 1.2% and 0% of the respondents rated the system "Fair", "Average" and 'Poor' respectively. Table 7 presents the comparative analysis of reported performance figures of the proposed JIT system with some previous and similar research works. The comparison was based on the purchase process, manufacturing support, inventory turnover/management, support for productivity and total quality control management. The values reported for the five indices show superiority in the performance of the JIT model over those presented in the previous works.

TABLE 7. Comparative analysis of the proposed system with some existing works

Performance Index	Reported Research	Macharia and Mukulu (2016)	Ribeiro & Machado (2014)	Qureshi *et al.* 2013)
JIT purchase process	51.10%	33.80%	26.00%	14.70%
Manufacturing support	40.00%	36.80%	11.00%	09.70%
Inventory Turnover/Management	45.70%	42.60%	10.00%	10.20%
Support for productivity	43.80%	41.10%	21.00%	10.50%
Total Quality Control Management	45.00%	22.10%	10.00%	14.60%

V. CONCLUSION

Inventory management is a common problem in the manufacturing industry, whether big or small. Rather than trusting on traditional production planning and control systems for running manufacturing operations which have exhibited failure at inventory management, Just-in-Time inventory management can be very useful for the reduction of manufacturing wastes, level of in-process inventories and finished goods as well as receipt of goods only as at when and where needed in the production process while meeting the ever-changing needs. The objective of the study was to establish a functional JIT system for stock ordering, control and management by manufacturing companies. The system is capable of directly or indirectly accommodating the various activities, people, and issues that are related to the production and distribution of goods and services. It equally presents a strong relationship between the various functional units in a production set-up and addresses issues relating to structure, systems, procedures and people through its four layers; namely customer interface, control interface, supplier interface and production control interface. The experimental study of the system was based on the ordering management of Eko Supreme Resources and Natural Prime Resources both in Lagos, Nigeria. Four classes of criteria were discovered as potential raw materials before implementation. Analysis of the figures obtained from the study revealed the proposed JIT system is endowed with the potential for minimizing costs and maximizing profits in the ordering system in the two companies. It was further confirmed that the JIT inventory method could offer massive improvements over the conventional methods in terms of ease of access and organizational and structural flexibility coupled with significantly reduced processing time. These findings justified the application of JIT inventory management principles needed for business survival amid some harsh realities of the modern business economy being experienced by some conventional inventory methods.

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