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Assessing the Application of Production Scheduling: Demand Uncertainty and the Performance of Manufacturing Firms in Rivers State, Nigeria

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Abstract

Manufacturing firms are expected to adopt best production practices accommodating production scheduling in the environment of demand uncertainty. Given that there is the gap between theory and practice, this study examined the extent production scheduling practices are involved in the operations of Nigerian manufacturing firms; and the relationship between production scheduling and manufacturing performance under demand uncertainty. The study involved the use of questionnaire to collect data from 29 manufacturing firms using random sampling from the population of 33 manufacturing firms registered with the Manufacturers' Association of Nigeria (MAN) in Rivers State, Nigeria. Relevant research questions and research hypotheses of the study variables; master production scheduling, operations scheduling and order scheduling as techniques of production scheduling on firm performance measures of productivity, market share and product quality were stated. Results of the study showed that master production scheduling, operations scheduling and order scheduling have above 75% influence on productivity and market share as compared to less than 40% influence on product quality. Concluding, that production scheduling has significant influence on performance of manufacturing firms in Rivers State, Nigeria, and that demand uncertainty affects the relationship between production scheduling and manufacturing firms' performance. It is recommended that manufacturing firms in Nigeria should effectively adopt production scheduling techniques in enhancing improved levels of manufacturing performance; and that the concept of demand as an input in production scheduling for a production plan period should accommodate unsatisfied demand from the immediate preceding plan period plus the forecast demand for that period.

Key Words: *Production scheduling, Demand uncertainty, Performance.*

Introduction

Many manufacturing firms generate and update production schedules, which are plans that state when certain controllable activities (processing of jobs by resources) should take place. For instance, manufacturers must schedule production, which means developing timing for workers, equipment, purchases and maintenance.

Scheduling is the activity of allocating a firm's resources, such as the workforce, machines, vehicles, and materials and the tasks to be executed within a certain period in the production of goods and services (Pinedo, 2008). Production scheduling pertains to establishing the timing of the use of specific resources in a firm. This relates with the overall production scheduling plan for the production process within some given period to give an idea to management as to what quantity of materials and other resources are to be procured and when, so that the total cost of operations of the organization is kept to the minimum over the period.

Scheduling is an important aspect of operations control in both manufacturing and service firms with increased emphasis on output levels, lead time in meeting demand and in satisfying the customer. Efficient scheduling plays increasing emphasis in ensuring the effective management of demand uncertainties. Uncertainty often stems from instability and dynamism in specific industry conditions such as demand, competitive actions, and technology. Due to demand uncertainty, firms as well as managers have the objective to schedule production in order to identify resources conflicts, control the release of jobs to the shop, ensure that required raw materials are ordered in time and also determine their workforce level in relation to demand uncertainties.

The demand for goods in most cases is very difficult to predict. Demand is uncertain when the volume or specific needs of customers is unknown, but the future demand can be estimated using appropriate forecasting techniques. It is the uncertainty of demand level which gives rise to capacity planning. Therefore under uncertainty, manufacturing firms identify their present capacity state bearing in mind room for future expansion due to increased level of capacity need in meeting higher levels of product demand. When the expectation of changing demand levels cannot be adequately predicted hence production scheduling should be carried out to accommodate meeting demand. Therefore, high demand requirements absorb available capacity and the firm is likely to adopt necessary strategic decisions in coping with the demand. However, in situations of stable demand or low demand variability, the uniform schedule is preferred.

In an ideal manufacturing organization, production works perfectly according to schedule. However, in real situations the production activity is imperfect as production schedules become inaccurate or unfeasible due to disturbances of demand uncertainties. This causes the deviation of the actual production from that scheduled and the consequent complexity of finished goods inventory levels and capacity utilization. Such complexity if not properly managed could result in customer dissatisfaction (Huaccho, 2003).

The essence of production scheduling is fundamentally to avoid increased costs on production by having a scheduled programme that fits the production planning for a given period accommodating the uncertainties in product demand. This appears to flow from the reasoning that the demand for the firm's product is in a state of flux as low demand or high demand levels which can be estimated by applying forecasting techniques. This twin factor of meeting demand and having smooth operations of manufacturing firms can be characterized by adopting appropriate production scheduling options that can enhance production performance.

Nevertheless, as manufacturing firms in Nigeria grapple with the issue of appropriate production scheduling as a factor of meeting product demand, the issue of production efficiency of manufacturing firms is ignored. Considering this situation, this study identified production scheduling in terms of master scheduling, operation scheduling and order scheduling and how they influence the performance of manufacturing firms in terms of productivity, market share, and product quality.

Today's production and operations managers in Nigerian manufacturing firms face many challenges with respect to demand uncertainty; therefore, the justification for this study was to contribute to knowledge on performance of Nigerian manufacturing firms by empirically examining the relationship between production scheduling and manufacturing performance accepting demand as a moderating variable of manufacturing firms in Rivers State, Nigeria.

Literature Review

Burton (1995) defined production scheduling as the process of ensuring that the right things are done at the right time with the right resources to create the right output through the most efficient utilization of resources. Vollmann (1997) had stated that within an organization, production scheduling pertains to establishing the timing of the use of specific resources of that organization, for example, the use of

equipment, facilities, resources and employee activities in production. Hopp and Spearman (1996) holds that scheduling encompasses allocating work load to specific work centers and determining the sequence in which operations are to be performed. They reiterated that scheduling tasks are largely a function of the volume of system outputs. Therefore, the volume of output determines the scheduling approach to be adopted.

Meanwhile, Herrmann (2003) defined production schedules as plans that state when certain controllable activities (processing of jobs by resources) should take place. He stated that production scheduling coordinate activities to increase productivity and minimize operating cost. A production schedule can identify resources conflicts, control the release of jobs to the shop, ensure that required raw materials are ordered in time, determine whether delivery promises can be met, and identify time periods available for preventive maintenance.

There are several approaches that can be adopted by decision makers in production schedules that vary output rate that fluctuates with variations in demand. Workforce levels are adjusted through the process of varying workforce levels by hiring, firing or lay off of production employees to produce output levels to match demand requirements.

The strategic approach of hire and layoff shows the extent to which the production operations are labour intensive. Considerations on the hire and layoff depend largely on union\management agreements which include, but not limited to layoffs and hiring of regular and temporary staff. Also affecting hire and layoffs are employment or hiring constraints due to labour laws external to the organization but to which the organization are bound to comply with; and union agitations in protecting current employee.

The hire and layoff have some cost implications. For instance, cost estimates according to Banjoko, (2002) include recruitment costs involving: screening, selection and training; layoff cost which include severity pay and other associated costs of realigning the remaining workforce and the intangible cost of low worker morale.

Overtime and slack time is the other essential strategic option akin to using employees in having varying output levels. The use of overtime\slack time is a more useful approach to changing capacity to meet demand. Overtime may result in lower productivity, poorer quality, more accidents, and increased payroll costs. On the other hand, Slack time results in less efficient use of machines and other fixed assets.

However, the advantages involved in these processes appear to be demonstrated in the following positive manifestation: Investment in inventory is low; labour utilization is kept high, that is, hire extra employee where necessary to increase output, or the use of overtime or layoffs where demand is short or below normal capacity. To overcome layoffs especially where company policy is against layoffs, slack time programmes can be initiated or by stimulating or creating new demand for products or services that require the same production processes in utilizing the excess capacity.

The other approach would be to use backorders. The backorder is a way of moving demand from one period to another, preferably to periods in which demand is lower, thereby smoothing demand requirements over time (Chopra *et al*, 2004). Thus, a backorder is a promise to a customer's order to deliver the product at a later date when it is more convenient to do so, usually when capacity begins to catch up with diminishing demand. The backorder therefore allows moving demand from one period to another especially to such periods where the demand can be accommodated together with the normal production rate for that period; or to a period where demand is lower but ensuring that such deferred delivery dates are mutually agreed by the consumer (Chopra *et al*, 2004).

In a manufacturing facility, the production scheduling system is a dynamic network of persons who share information about the manufacturing facility and collaborate to make decisions about which jobs should be

done and when. The information share includes the status of jobs (also known as work orders), manufacturing resources (people, equipment, and production lines), inventory (raw materials and work-in-process), tooling and many other concerns.

Thus, production scheduling is designed to achieve the following objectives which according to Kumar and Suresh (2008) are:

- To organize the production facilities like machines, men to achieve stated production objectives with respect to quantity and quality time and cost.
- To conform to delivery commitments.
- To be able to make adjustments to changes in demand (demand uncertainty) and rush orders.
- Coordinating with other departments relating to production to achieve regular balanced and uninterrupted production flow.

Master Production Scheduling (MPS)

Following from the production schedule is the MPS showing week by week how many of each product must be produced according to customer orders and demand forecasts (Kumor and Suresh, 2008). The MPS is an important link between marketing and production. It shows when incoming sales orders can be scheduled into production and when each shipment can be scheduled for delivery. It expresses the overall plans in terms of specific end items or models that can be assigned priorities. The time interval used in master scheduling depends upon the type, volume and component lead times of the products being produced.

The MPS has a large effect on firm's performance, such as the efficiency and flexibility of a firm, by determining its order lead times, delivery flexibility, machine and material usage and staff work load (Pinedo, 2008). The MPS is a link between the firm's broad strategies and tactical plans that enables the firm to achieve its goals. The main tool to control product availability is the master production schedule. By using the beginning inventory and the sales forecast for a particular end item, a planner can calculate the amount of product needed per period to meet anticipated customers' demand. This calculation becomes more complex in a multi-product environment where forecast errors and capacity constraints can add a great deal of uncertainty to the planning process. As firms continue to integrate the MPS into supply chain planning, it is becoming increasingly clear that the MPS plays a major role in managing the trade-off between costs and product availability (Closs and Nair, 2001).

Therefore, Master production scheduling is the basis for making customer delivery promises, utilizing plant capacity effectively, attaining the firm's strategic objectives as reflected in the production plan and resolving trade-off between manufacturing and marketing. It provides essential information for functional areas such as operations, marketing and finance. Kumor and Suresh (2008) identified six functions of MPS which are:

- To translate aggregate plans into specific end items: Aggregate plan determines level of operations that tentatively balances the market demands with the material, labour and equipment capabilities of the manufacturing organization. A master schedule translates this plan into specific time period.
- Evaluate alternative schedules: To avoid trial and error in master scheduling, many computer simulation models are available to evaluate the alternate schedule.
- Generate material requirement: It forms the basic input for material requirement planning.
- Generate capacity requirements: Capacity requirements are derived from MPS.
- Facilities information processing: By controlling the load on the plant. Master schedule determine when the delivery should be made. It coordinates with other management information systems such as, marketing, finance and personnel.
- Effective utilization of capacity: By specifying end item requirements, master production schedule establishes the load and utilization requirement for machines and requirement.

Other functional areas in the firm can use the MPS for routine planning. Finance uses the MPS to estimate budgets and cash flows. Marketing can use it to project the impact of product mix changes on the firm's ability to satisfy customer demand and manage delivery schedules. Manufacturing can use it to estimate the effects of MPS changes on loads at critical workstations. All these are geared towards increasing the productivity, product quality and market share of the firm's performance.

Operations Scheduling

The other scheduling approach is the Operation Scheduling where jobs are assigned to workstations or employees are assigned to jobs for specified time periods. Operations scheduling is a type of scheduling in which jobs are assigned to workstations or employees are assigned to jobs for specified time period. Meeting due dates, minimizing job flow time, minimizing manufacturing costs, and maximizing machine (or operator) utilization are the managerial considerations in operation scheduling.

However, one way to generate schedules in job shops is by using priority sequencing rules, which allows the schedule for a workstation to evolve over a period of time. The decision about which job to process next is made with simple priority rules whenever the workstation becomes available for further processing. One advantage of this method is that last-minute information on operating conditions can be incorporated into the schedules as it evolves.

The functions of operations scheduling are classified as short or long term planning functions which include, planning manufacturing resources (developing production resources for special purpose machine task), planning preparation (compile planning documents), cost planning (preliminary costing, feasibility study), quality assurance (inspection planning, quality planning), investment planning (manufacturing resources, facilities), and material planning (types of store and store location) (Snoo, Wezel, and Jorna, 2011).

Whereas the economic aspects of order processing are planned and specified in the manufacturing and assembly areas as short-term activities, the objectives of long-term planning is to develop appropriate measures to ensure that the organization and layout of these areas is economically efficient.

According to Kumor and Suresh (2008) operations scheduling is concerned with the volume and timing of outputs, the utilization of operations capacity at desired levels for competitive effectiveness. They identified the following components of operations scheduling:

a. The Business Plan: The business plan is a statement of the organization's overall level of business activity for the coming six to eighteen months, usually expressed in terms of outputs (in volume of sales) for its various product groups, a set of individual product that share or consume common blocks of capacity in the manufacturing process.
b. Aggregate production planning: The process of determining output levels of product groups over the coming six to eighteen months on a weekly or monthly basis.
c. Aggregate capacity planning: It is the process of testing the feasibility of aggregate output plans and evaluating overall capacity utilization. It addresses the supply side of the firm's ability to meet the demand.
d. Weekly production scheduling: Is a schedule showing week by week how many of each product must be produced according to customers' orders and demand forecast.
e. Resources requirement planning: Is the process of testing the feasibility of master production schedule in terms of capacity.
f. Material Requirement Planning: Is a system of planning and scheduling the time phase material requirement for releasing materials and receiving materials that enable the master production schedule to be implemented.

g. Capacity Requirement Planning: Is an iterative process of modifying the MPS or planned resources to make capacity consistent with the production schedule.
h. Shop Floor Control: Involves the activities that execute and control shop operations namely loading, sequencing, and expediting jobs in production.
i. Input/Output Control: It relates to the activities to monitor actual versus planned utilization of a work centre's capacity.

However, Parker (2010) postulated on Order Scheduling which is based on the delivery dates, and the capacity requirements determined for all operations within an order. Also, Parker (2010) identified four types of order scheduling which are:

Forward Scheduling: Schedules the order for the product using the basic start date or the scheduled start date while including all operations and times to determine the finish date.

Backward Scheduling: Schedules the order backward using the basic finish date or the scheduled finish date while including all operation and times to determine the start date.

Schedule today: schedules the order forward using today's date while including all operations and times to determine the finish date.
Capacity requirement only: schedules the order based on capacity requirement only.

Following, Zhi-long and GuruPrasad (2009) proposed two areas of order scheduling in enhancing firm's performance: meeting the given deadliness of the orders and requiring the average delivery lead time of the orders to within a given threshold. However, order production enhances firms performance in terms of production, product quality and market share by making sure customers' orders are scheduled for and met or satisfied at given due dates.

Each job order arrival demands some amount of the resources, and a reward (unknowns prior to the job arrival) is received upon acceptance they provide an optimal acceptance policy that maximizes expected profits. For the batch process industry, Ivanescu, Fransco, Bertrand (2006), developed policies that focus on delivery reliability while keeping utilization rates up. The main aim is to minimize the total completion time of accepted jobs plus job rejection penalties. The scheduling parameters for production orders define the detailed scheduling of an order and determine adjustment of the dates in the production order.

Methodology

The method chosen for the study is the survey research design because of its requirements to collect data from a wide range of subjects to elicit acceptable generalization. The research process is concerned with the level of one or more variables or the association between certain variables. The study involved the use of questionnaire to collect information from the sample size of 29 manufacturing firms randomly selected from 33 manufacturing firms registered with the Manufacturing Association of Nigeria (MAN) in Rivers State, Nigeria.
The method used in collecting primary data involved the administration of questionnaire to the selected manufacturing firms in the survey as respondents. The variables in the questionnaire were measured using the Likert scale. The Likert scale is a technique that captures the responses of the variables in the study (Collis and Hussey, 2003).

The reliability analysis in Table 1 indicates that all dimensions of the dependent, independent and contextual variables had Cronbach's alpha value of ≥ 0.7 which is accepted as reliable measure, thus, it can be accepted that the research instrument measured the variables as in the content of the study.

Table 1: Result of Reliability Analysis

Variable	Cronbach's alpha
Independent Variables	
Master Production scheduling	0.914
Operations scheduling	0.896
Product Order scheduling	0.860
Dependent Variables	
Productivity	0.855
Market Share	0.903
Product Quality	0.763
Contextual Factor	
Demand uncertainty	0.756

Source: SPSS Output based on the field data 2013. Details in the Appendix

Data Presentation and Analysis

The raw data collected through the research instrument was analysed using the Statistical Package of Social Science (SPSS). The empirical findings from the study were used in deriving resultant answers to the research questions and the test of hypotheses towards achieving the purpose of the study which is to examine the influence of production scheduling on the performance of manufacturing firms in Rivers State, Nigeria.

From the presentation, it showed that 13.8% of the firms have been in existence between 5 to 15 years; 27.6% of the firms have been in existence between 5 to 15 years; while the majority of the firms (58.6%) have been in existence 26years and more. (See Appendix)

Master Production Scheduling and the performance of manufacturing firms

Three measurement items in the questionnaire were used to collect data on master scheduling and the responses presented in Table 2. It also includes responses based on each of the items on the questionnaire, indicating the associated responses and percentages on the categories of strongly disagree/disagree and agree/strongly agree.

Table 2: Summary of findings on Master Production scheduling

Item	Variable	Percentages	
		Strongly Disagreed/Disagreed	Agreed/Strongly Agreed
Q1	Master Production scheduling is a major tool to enhance coordination in my firm in order to meet customers demand.	6.9	72.4
Q2	Master Production scheduling do reduce waste by helping your firm make the right products at the right time, thereby avoiding unneeded inventory and obsolescence.	10.3	65.5
Q3	Master Production scheduling is an important tool to satisfying customers' need during demand uncertainty.	6.9	58.6

Source: SPSS Output based on the field data 2013. Details in the Appendix

Table 2 showed that 72.4% of the manufacturing firms accepted that master production scheduling is a major tool in the production process in bringing about output levels to meet customers demand. Also, 65.5% of the firms indicated that master production scheduling do reduce waste by helping the firm make the right products at the right time, thereby avoiding unneeded inventory. Furthermore, 58.6% of the manufacturing firms accepted that master production scheduling is an important tool to satisfying customers' need during demand uncertainty. Master production scheduling accommodates future demand forecasts in production output levels that ease out high and low demand levels.

Also, presented are the correlation values of the relationship between master production scheduling as the predictor variable and firm performance as the criterion variable, and then on each of the measures of performance as shown in Table 3.

Table 3: Influence of Master Production scheduling on Firm Performance

S/N	Factor	r	r^2	Percentage
1.	Master scheduling on Firm performance	0.807	0.651	65.10%
2.	Master scheduling on Productivity	0.924	0.8538	85.38%
3.	Master scheduling on Market share	0.875	0.7656	76.56%
4.	Master scheduling on Product Quality	0.942	0.8874	88.74%

Source: SPSS Output based on the field data 2013. Details in the Appendix

From Table 3, the relationship between master production scheduling and firm performance showed that the correlation coefficient (r) = 0.807. This indicates that a strong positive relationship exists between master production scheduling and firm performance.

On the relationship between master production scheduling and productivity, the correlation coefficient (r) = 0.924. This shows that a very strong positive relationship exists between master production scheduling and productivity.

On the relationship between master production scheduling and market share, r = 0.875 indicating that a strong positive relationship exist between master production scheduling and market share. The relationship between master production scheduling and product quality indicates that r = 0.942. The correlation value shows a very strong positive relationship exists between master production scheduling and product quality.

The r^2 values, indicating the coefficient of determination showed that master production scheduling have more influence on the outcome of productivity and product quality compared to that of market share in the performance measures.

Operations scheduling and the performance of manufacturing firms

Three measurement items in the questionnaire were used to collect data on operations scheduling and the response presented in Table 4. This includes responses based on each of the items on the questionnaire, indicating the associated responses and percentages.

Table 4 showed that 79.3% of the respondents accepted that inconsistency in scheduling in terms of use of equipment and facilities in operations scheduling affects the performance of manufacturing firms; while 72.4% of respondents accepted that late delivery of raw materials in operations scheduling affects the performance of their firms. Again, 65.5% indicated that low materials quality in operations scheduling affects the performance of their firms.

Table 4: Summary of findings on Operations scheduling

S/N	Variable	Percentages	
		Strongly Disagreed/Disagreed	Agreed/Strongly Agreed
Q1	Inconsistency in scheduling in terms of use of equipment and facilities affects the performance of your firm.	6.9	79.3
Q2	Late delivery of raw materials affects the performance of your firm.	6.9	72.4
Q3	Low materials quality affects the performance of my firm.	6.9	65.5

Source: SPSS Output based on the field data 2013. Details in the Appendix

Also, presented are the correlation values of the relationship between Operations scheduling as the predictor variable and firm performance as the criterion variable, and then on each of the measures of performance as shown in Table 5.

Table 5: Influence of Operations Scheduling on Firm Performance

S/N	Factors	r	r^2	Percentage
1.	Operations scheduling on Firm performance	0.885	0.7832	78.32%
2.	Operations scheduling on Productivity	0.884	0.7815	78.15%
3.	Operations scheduling on Market share	0.967	0.9351	93.51%
4.	Operations scheduling on Product Quality	0.537	0.2884	28.84%

Source: SPSS Output based on the field survey data 2013. Details in the Appendix

The relationship between Operations scheduling and firm performance indicates that r = 0.885. This indicates that a strong positive relationship exist between operations scheduling and firm performance. On the relationship between Operations scheduling and productivity, the correlation coefficient (r) = 0.884. This shows that a strong positive relationship exist between Operations scheduling and productivity. On the relationship between Operations scheduling and market share, r = 0.967 indicating that a very strong positive relationship exist between Operations scheduling and market share.

The relationship between Operations scheduling and product quality indicates that r = 0.537. This shows a comparative weak relationship between Operations scheduling and product quality. The data on the effect of operations scheduling on product quality seem inconsistent when the operations scheduling has a very high degree (93.51%) on market share. However, the relationship Operations scheduling has 78.32% degree of effect on firm performance.

Order Scheduling and the performance of manufacturing firms

Three measurement items in the questionnaire were used to collect data on competitive markets. The responses and their corresponding percentages are presented in Table 6.

Table 6 showed that 69.0% of firms accepted that in product order scheduling, due date approach in scheduling production affects the performance of their firms; while 55.1% of firms indicated that first come, first served used in product order scheduling affects the performance of their firms. Also, 55.1% of the firms showed that in sequencing job, the shortest processing time approach used in product order scheduling affects the performance of their firms.

Table 6: Summary of findings on Order Scheduling

S/N	Variable	Percentages	
		Strongly Disagreed/Disagreed	Agreed/Strongly Agreed
Q1	In sequencing job, my firm uses due date approach in scheduling production.	13.8	69.0
Q2	First come, first served is frequently used in sequencing job in my firm.	17.2	55.1
Q3	In sequencing job, my firm uses the shortest processing time approach for each job in scheduling production.	10.3	55.1

Source: SPSS Output based on the field data 2013. Details in the Appendix

Also, presented are the correlation values of the relationship between Order scheduling as the predictor variable and firm performance as the criterion variable, and then on each of the measures of performance as shown in Table 7.

Table 7: Influence of Order Scheduling on Firm Performance

S/N	Factors	r	r^2	Percentage
1.	Order scheduling on Firm performance	0.820	0.6724	67.24%
2.	Order scheduling on Productivity	0.857	0.7344	73.44%
3.	Order scheduling on Market share	0.786	0.6178	61.78%
4.	Order scheduling on Product Quality	0.603	0.3636	36.36%

Source: SPSS Output based on the field data 2013. Details in the Appendix

The relationship between Order Scheduling and firm performance as shown in Table 7 indicates that the correlation coefficient (r) = 0.820. This show a strong significant relationship exists between Order Scheduling and firm performance. The relationship between Order Scheduling and productivity has a correlation coefficient (r) = 0.857. This shows that a strong positive relationship exist between Order Scheduling and productivity.

On the relationship between Order Scheduling and market share, r = 0.786 indicating that a strong positive relationship exist between Order Scheduling and market share. On the relationship between Order Scheduling and product quality, the correlation coefficient (r) = 0.603. This showed a positive relationship exists between Order Scheduling and product quality but the degree of effect of order scheduling on product quality in firm performance is less than 50%.
The r^2 values show that Order scheduling has more influence on productivity (> 70%) than market share.

Demand uncertainty as a moderating variable in the relationship between Production scheduling and the Performance of manufacturing firms

Three measurement items in the questionnaire were used to collect data on demand uncertainties and the responses presented in Table 8. From the Table (Table 8), 41.3% of the firms accepted that scheduled production output for a given period, is due to the demand and available capacity for that period; 58.6% accepted that there exists a situation when unsatisfied demand for a period is pushed beyond another period and 58.6% showed that often, there exists higher degree of fluctuations in product demand.

Table 8: Summary of findings on demand uncertainties

S/N	Variable	Percentages	
		Strongly Disagreed/Disagreed	Agreed/Strongly Agreed
Q1	Production output for a given period is due to the demand and available capacity for that period.	31.0	41.3
Q2	In my firm, there exists a situation when unsatisfied demand for a period is pushed beyond another period.	17.2	58.6
Q3	Oftentimes there exists higher degree of fluctuations in product demand of your firm's products.	24.1	58.6

Source: SPSS Output based on the field data 2013. Details in the Appendix

The results showed that on the average 68.67% of firms indicated that demand uncertainty is a factor in production scheduling and its attendant effect on the performance of manufacturing firms in Rivers state, Nigeria.

Hypotheses Testing

The test statistic (t value) was used to test each of the hypotheses. From Table 3; Table 5 and Table 7; the r and r^2 values of the correlation between master production scheduling and firm performance; operations scheduling and firm performance; and order scheduling and firm performance respectively are stated and subsequently the respective t-values. The results of the relevant statistics are presented below.

Table 9: Results of Test of Hypotheses

S/N	Hypothesis (stated the in null form)	r	r^2	t-value	Remarks
1	There is no significant influence of master production scheduling on the performance of manufacturing firms	0.807	0.651	0.7873	Significant
2	There is no significant influence of operations scheduling on the performance of manufacturing firms	0.885	0.7832	0.8659	Significant
3	There is no significant influence of order scheduling on the performance of manufacturing firms	0.820	0.6724	0.8008	Significant
5	That demand uncertainty as a moderating variable does not affect the relationship between production scheduling and the performance of manufacturing firms		Zero-order r=0.934	Controlled r = 0.893	Significant

Source: SPSS Output based on the field data 2013. Details in the Appendix

Hypothesis 1

Ho_1: There is no significant influence of Master Production Scheduling on the performance of manufacturing firms.

From Table 9 the t-calculated of the influence of master production scheduling on firm performance is 0.7873. Conventionally, the decision rule is to accept the null hypothesis, if the critical t-value is less than the t-calculated value. That is, if t-critical ≤ t-calculated, then the null hypothesis is accepted; otherwise the null is rejected when the t-critical ≥ t-calculated with (n-1) degree of freedom, at 0.05 level of significance.

From the analysis, the calculated t-critical at 28 df on 0.05, is 1.701 which is greater than t-value (0.787); that is, t-tab =1.701 > t-cal=0.787$_{(0.05, 28)}$ level of significance. Thus, the hypothesis is rejected based on the comparison of the calculated t-value and the tabulated t-value. Therefore, master production scheduling has a significant influence on the performance of manufacturing firms in Nigeria.

Hypothesis 2

Ho$_2$: There is no significant influence of Operations scheduling on the performance of manufacturing firms.

Table 9 showed that operations scheduling had a calculated t-value of 0.8659. The decision criterion is to accept the null hypothesis if the critical t value is less than the calculated value of t. Since t-calculated = 0.866 < t-tab =1.701$_{(0.05, 28)}$ level of significance, thus the hypothesis is rejected based on the comparison of the calculated t-value and the tabulated t-value and therefore, there is a significant influence of operations scheduling on the performance of manufacturing firms in Nigeria.

Hypothesis 3

Ho$_3$: There is no significant influence of Order scheduling on the performance of manufacturing firms.

Again from Table 9, it showed that product order scheduling had a calculated t-value of 0.8008. The decision rule is to accept the null hypothesis if the critical t value is less than the calculated value of t. Since t-calculated = 0.866 < t-tab =1.701$_{(0.05,28)}$ level of significance, therefore the hypothesis is rejected based on the comparison of the calculated t-value and the tabulated t-value, and it is concluded that order scheduling significantly influence the performance of manufacturing firms in Nigeria.

Hypothesis 4

Ho$_4$: That demand uncertainty as a moderating variable does not affect the relationship between Production scheduling and Performance of manufacturing firms.

From the statistical values presented in Table 10 below, is the input of the test of hypothesis of the contextual variable that demand uncertainty as a moderating variable affects the relationship between production scheduling and the performance of manufacturing firms in Nigeria.

Table 10: Demand uncertainty on the influence of Production Scheduling on Firm Performance

Correlations

Control Variables	Variables	Statistics	Production Scheduling	Performance	Demand Uncertainty
-none-[a]	Production Scheduling	Correlation	1.000	.934	.615
		Significance (2-tailed)	.	.000	.000
		df	0	27	27
	Performance	Correlation	.934	1.000	.689
		Significance (2-tailed)	.000	.	.000
		df	27	0	27
	Demand Uncertainty	Correlation	.615	.689	1.000
		Significance (2-tailed)	.000	.000	.
		df	27	27	0
Demand Uncertainty	Production Scheduling	Correlation	1.000	.893	
		Significance (2-tailed)	.	.000	
		df	0	26	
	Performance	Correlation	.893	1.000	
		Significance (2-tailed)	.000	.	
		df	26	0	

a. Cells contain zero-order (Pearson) correlations.

Source: SPSS Output based on the field data 2013. Details in the Appendix

Table 10 showed that there is a correlation between Demand uncertainty and Production Scheduling as (r) = 0.615; and a correlation between Demand uncertainty and Firm Performance as (r) = 0.689.

Also, from the Table (Table 10) a strong correlation exists between Production Scheduling and firm performance (r) = 0.934. However, when Demand uncertainty is controlled, the relationship between Production Scheduling and firm performance (r) becomes 0.893. Since the difference between the zero order correlation and the controlled correlation (0.934 - 0.893) = 0.041 > 0.01, therefore, Demand uncertainty significantly affect the relationship between Production Scheduling and firm performance of manufacturing firms in Nigeria.

Summary of Findings

Consequent of the research findings from the data analysis the following are the summary of findings:

1. That master production scheduling has 85.38% influence on productivity; 76.86% influence on market share; and 88.74% influence on product quality. Subsequently, from the findings, master production scheduling has significant influence on the performance of manufacturing firms in Rivers State, Nigeria.

2. That operations production scheduling has 78.15% influence on productivity; 93.51% on market share; and 28.84% on product quality. Therefore, operations scheduling has a significant positive influence on the performance of manufacturing firms in Rivers State, Nigeria.

3. That product order scheduling has 73.44% influence on productivity; 61.78% on market share; and 36.36%. Following from the findings, that order scheduling has significant influence on the performance of manufacturing firms in Rivers State, Nigeria.

4. That Operations scheduling have a higher significant percentage (78.32%) compared to master production scheduling with significant percentage of 65.10%; and product order scheduling (67.24%) influence on the performance of manufacturing firms in Rivers State, Nigeria.

5. That master production scheduling has more significant result on product quality than operations scheduling and order scheduling. Also, it is shown from the findings that operation scheduling has more influence on market share as compared to the other scheduling approaches.

6. That demand uncertainty as a mediating variable affects the relationship between production scheduling and the performance of manufacturing firms in Rivers State, Nigeria.

Discussions of Findings

The discussions of the findings followed the relationship between each of the production scheduling approaches and the performance of manufacturing firms.

Master Production Scheduling and Manufacturing Firms Performance

Master production scheduling (MPS) show week by week how many of each product must be produced according to customer orders and demand forecasts. From the analysis of Table 2, it showed that 72.4% of the manufacturing firms accepted that master production scheduling is a major tool in the production process in bringing about output levels to meet customer demand which correspond to the view of Kumor and Suresh (2008). They opined that MPS is an important link between marketing and production. It shows when incoming sales orders can be scheduled into production, and when each shipment can be scheduled for delivery. The ability to meet the demand for individual (consumer) products in the product group will in turn increase the market share of the firm.

From the analysis on the relationship between master production scheduling and productivity, the correlation coefficient (r) = 0.924 indicate a very strong relationship exist between master production scheduling and productivity. Using productivity as a measure of firm's performance, it shows master production scheduling has influence on manufacturing firm's performance. It also takes into account current backlogs so that production output in meeting customers' demand and delivery schedules are realistic (Kumor and Suresh (2008). These confirm the analysis in Table 3 on the relationship between MPS and firm performance. The correlation coefficient (r) = 0.807, that is, about 65% of the influence of MPS on the performance of manufacturing firms.

MPS determines when the delivery should be made and coordinates with other management information from marketing, finance, personnel in the manufacturing process providing the basis for making customer delivery promises, utilizing capacity effectiveness as reflected in the production plan and resolving tradeoff between manufacturing and marketing which are geared to the improvement of productivity, product quality and market share.

The MPS provides essential information for functional areas such as operations, marketing and finance for routine planning. Finance uses it to estimate budgets and cash flows, marketing can use it to project the impact of product mix changes on the firm's ability to satisfy customer demand and manage delivery schedules while manufacturing can use it to estimate the effects of changes in production load at critical workstations (Edmund, Hyong, Stuart, Prinki, and Ping 2007).

Thus, MPS plays a major role in managing the trade-off between product output and product availability through determining the beginning inventory and the sales forecast for a particular end item. This confirm from the findings that MPS have strong positive influence on the measures of the performance of manufacturing firms (Master scheduling on Productivity, r = 0.924; Master scheduling on Market share, r = 0.875; Master scheduling on Product Quality, r = 0.942).

Operation scheduling and manufacturing firm's performance

Operation scheduling minimize the throughput times of material and capital commitment and to ensure that capacities are fully utilized and that operating resources and labour cost are kept low in order to increase the performance of the firm (Schuh, 2006). Also, the operation schedule helps to improve productivity and minimizes the makespan (the total amount of time required to complete a group of jobs) and product delivery time. Production Managers are mainly concerned with the short-term tasks such as scheduling, maintaining efficiency levels, monitoring controls and resolving factory labour problems. However, the concept of managing production has moved to the complexity in product range, product mix, volume changes, process flexibility, inventory, cost and financial controls, and employee awareness because of the more intensive level of domestic and international competition (Hill, 2000).

Maximizing the degree to which equipment, space or the workforce is currently being used, measured as the ratio of the average output rate to maximum capacity is a function of operations scheduling in enhancing the performance of the firm. This confirm the analysis in Table 5 in regard to the relationship between operations scheduling and productivity, the correlation coefficient (r) = 0.884. This shows that a strong positive relationship, exist between operations scheduling and productivity. From Table 9, operations scheduling had a calculated t-value of 0.866 indicating a significant influence of operations scheduling on the performance of manufacturing firms in Rivers State, Nigeria.

However, the data on the relationship between operations scheduling and product quality showed the correlation coefficient (r) = 0.537 indicating that operations scheduling has a low (28.84%) degree of influence on product quality as compared to the relationship between operations scheduling and market share with a correlation coefficient (r) = 0.967 indicating a very high degree (93.51%) of influence on

market share. This inconsistency can be explainable if the manufacturing firm offers a lower price for the product compared to price of competitors. If the price is low and the product that has low quality is satisfying the need of the consumer, there is bound to be increase in the demand which can translate to increase in market share for the product.

Order scheduling and manufacturing firms' performance

Order scheduling is an important aspect of a job shop intermittent production system where production is solely based on demand for the product. The job shop scheduling problem can be stated as follows: which jobs are to be processed by which machines or work stations within a given time period in such way that given objectives is optimized. Each job consists of a specific set of operations which have to be processed according to a given technical precedence in order to achieve the firms' objectives and goals. The aim of the planning process (job order scheduling) is to find a schedule for processing all jobs optimizing one or more goals, for instance, minimizing means flow time (Oliver and Rajendran, 1996).

The job order scheduling constitutes the link between the equipment or the facility in need of services and the organization as a whole and in particular the departments involved in providing the service. The basic purpose of the job order system therefore is to provide a means of screening and authorizing work, to provide cost data and to provide feedback information in the production (Oliver and Rajendran, 1996). This is evident from the findings that job order scheduling has significant influence on productivity with the correlation coefficient (r) = 0.857.

Higher productivity levels enhances firm performance in ensuring that jobs are produced to order in meeting the given deadlines of the product orders and thus minimizes the average delivery lead time of the product orders which eventually leads to increase in market share (Zhang, 2011). This agreed with the findings that there is a positive relationship between product order scheduling and productivity and market share (r) = 0.786.

Conclusion

Production schedules identify resources conflicts, control the release of jobs to the shop, and ensure that required materials are ordered in time (Hermann, 2003). A production schedule gives shop floor personnel an explicit statement of what should be done so that supervisors and managers can measure their performance. Efficient production scheduling balances the length of production runs (production run length is the number of days a process line is scheduled to produce the same product).

With an increasing emphasis on the multiple objectives on delivery time, low inventory and production quality, the management of the plant needs production scheduling for better system performance. Building quality in planning is a necessary step to enhancing the reliability of work flow and subsequently, achieving high productivity and improved product quality. These can only be realized through production scheduling. Scheduling prevents bottlenecks from occurring and keeps operations range smoothly during cyclical swings. This is especially true for businesses prone to seasonality, regardless of whether the upturn or decline is in material supply or sales (Torbjorn, 2012). Lack of proper scheduling is one of the primary reasons for manufacturing firms' low productivity and weak revenues, due to low market share. In most cases, market shares mean shares of the actual sales for a product in a given period and in a given geographical area; that is, sales performance of a product class in the market, rather than a collection of buyers for the product (Cooper and Nakanishi, 2010). However, it does not follow logically that seeking higher market share will improve profits. Rather the correlation between market share and profitability is more logically interpreted as showing that firms with better offerings tend to achieve higher market share (Scott and Green, 2006).

As globalization takes place, the market is getting more and more competitive. Manufacturing firms are facing tremendous pressure to succeed in the marketplace with increasing productivity, product quality and market shares of competitors. This has led to manufacturing firms in having best production scheduling practices as to maximize productivity and optimizing resource capacity utilization. Thus, the effort in having an efficient interplay of master production scheduling, operation scheduling and order scheduling will result in reduction of production costs, reduction of production lead times as a means of having competitive advantage in the marketplace to effectively cope with dynamic changes of customer demand in the market (Zhang, 2011).

Conclusively, production scheduling is an important production function in realizing increased market share, profitability, productivity, reduced costs, improved product quality and increase in market share and market responsiveness resulting in satisfying the customer and improved customer relationship (Ming and David, 2011).

Recommendations

From the study the following recommendations are suggested.

1. Manufacturing firms in Nigeria should use master scheduling as a strategy in planning manufacturing resources, equipment, facilities in enhancing improved levels of manufacturing performance.

2. Manufacturing firms should use the shortest processing time to minimize average flow time; however, this approach should accept interruptions in meeting due dates where unavoidably necessary in order to meet customer demand.

3. That the concept of demand as an input in production scheduling for a production plan period should accommodate unsatisfied demand from the immediate preceding plan period plus the forecast demand for that period.

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