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APPLICATION OF TRANSPORTATION AND INVENTORY MODELS ON OPERATIONS AND PERFORMANCE OF MANUFACTURER REPRESENTATIVES FIRMS IN AKWA IBOM STATE, NIGERIA

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Abstract: The study was carried out to ascertain the effects of the application of transportation and inventory models on the operations and performance of manufacturer representatives' firms in Akwa Ibom State. This follow the fact that it seems the application of these models in real life situation is so complex, most managers shy away from their adoption in decision making process. Survey research design was employed in the study using questionnaire to obtained data from one hundred and twenty-two (122) firms which constituted the sample of the study. The dependent variable was operational efficiency/performance, while transportation and inventory models were the independent variables. The data were analyzed using descriptive statistics and simple linear regression analysis. Results revealed (TM: t-stat = 5.791, R^2 = 0.58, F-ratio = 166.66, P<0.05; InM: t-stat = 22.278, R^2 = 0.508, F-ratio = 123.94, P<0.05) that transportation and inventory models significantly and positively influenced operations and performance of studied firms. It was concluded that quantitative models affect operations and performance of these entities and recommended that other models such as forecasting and assignment

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models as well as computerizations of operations be imbibed by the managers to foster their operations and performance.

Keywords: Transportation and inventory models, performance, decision making, quantitative models.

1. INTRODUCTION

In the changing global business environment, where there is changes in knowledge, innovation and technology, and complex decision-making situations, there is need to embrace decision-making models. These would be used to enhance the decision-making processes instead of using head knowledge, rule of thumb, and experiences as often seen by many managers. Thus, ensuring that the profit maximization and cost minimization objectives of the firms are achieved. The firm managers need to use qualitative and especially more of quantitative measures to analyse data with the aid of statistical tools. Quantitative measures analytics are scientific approach to decision making. They are concerned with the application of mathematical and advance statistical models in generating quantitative information needed for managerial decision making.

Modeling and techniques of quantitative methods are traced to World War 1 following an effort by "Thomas Edison to use a tactical game board for finding a solution to minimize shipping losses from enemy submarines, rather than risking ships in actual war conditions" (Sharma, 2013). Since then, complexities in economic, social and industrial operations, there had been growth in the development of quantitative (operations research) techniques to address managerial decision making problems for enhancing the optimal use of scare resources.

Operational Research Society, (UK.) in Sharma (2013) defined operation research as "the application of the methods of science to complex problems in the direction and management of large systems of men, materials, and money in industry, business, government and defense. The distinctive approach is to develop a scientific model of the system incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management in determining its policy and actions scientifically".

In practice, quantitative models may be applied to solve managerial problems in areas as inventory, queuing (waiting line), replacement of assets, Networking, sequencing, transportation (Factory-warehouse distribution), break-even analysis and among others. The models to apply depends on the

nature of the organization, the product or service features. In this study, we focus on transportation and inventory models used by manufacturer representatives' firms in the management of their supply chain.

The performance of firms depends on how best managers optimize resources through effective and efficient decision making which ultimately anchors on the nature and types of decision making models used. Manufacturer representative firms are companies which provide warehousing facilities to both national and multinational manufacturing companies with factories located outside of Akwa Ibom State, Nigeria, such as Lagos, Ibadan, Kaduna, Kano, Aba, Enugu, among other industrial locations but aim at ensuring effective and efficient distribution of their products across the country. The optimization of quantity to transport and warehouse for efficient distribution might require an understanding of some quantitative technique models such as "inventory and transportation" models. However, the applications of these models by these entities in their operations require empirical investigation, which the researchers seek to address.

1.1. Statement of the Problem

In practice and real Scenario, it seems application of quantitative models is so complex that managers of companies often shy away, preferring the adoption of rule of thumb or trial and error when deciding on which alternative to choose, particularly among Nigerian business managers who may not have been exposed to the models or find them difficult to understand.

Also, several studies that have been conducted had not really dwell on the specific applications of these QT tools by manufacturer representatives in their decision making. This present study is conducted to bridge this gap in the empirical literature particularly in developing economy on application of the selected QT models in managing logistics problems by these group of managers.

1.2. Objectives of the Study

The main objective of the study is to ascertain whether quantitative models adopted by manufacturer representatives' firms enhance their operations and performance.

Specific objectives include:

(i) To find out how adoption of transportation model has affected the operations and performance of manufacturer representation firms in Akwa Ibom State.

(ii) To examine the effect of the adoption of inventory model on the performance and operations of manufacturer representations firms in Akwa Ibom State.

1.3. Research Questions

The research questions are:

(i) Does the adoption of transportation model have any significant effect on the operations and performance of manufacturer representative firms in Akwa Ibom State?

(ii) What is the effect of the adoption of inventory model on the operations and performance of manufacturer representative firms in Akwa Ibom State?

1.4. Significance and Scope of the Study

This study is significant because it will assist logistic managers and other decision makers on the relevance of adoption of quantitative models in performance improvement and operational efficiency through optimization principles. Other researchers will find the study significant for further studies as reference materials.

On the scope, content-wise, we are concerned with only two (2) Operations Research (OR) or Quantitative Techniques (QT) models – transportation and inventory models which we assumed as directly related to logistics management. Other models are left out in the study. Geographical wise, we concentrated on manufacturer representatives' firms situated only within Uyo metropolis, the Akwa Ibom State Capital, Nigeria.

2.. REVIEW OF RELATED LITERATURE

2.1. Conceptual Review and Framework.

The key concepts of the study are explained in this section of the paper.

2.1.1. Transportation Model

The framework of transportation problem embraces a large number of shipping routes from different supply centres to different demand centres. It deals with problems concerning as to what happens to the effectiveness function when associating each of a number of origins (sources) with each of a possibly different number of destinations (jobs) (Sharma, 2013; Gupta &Hira, 2011). The main

objective being to determine the number of units of an item, commodity or product that should be transported from an origin to a destination in order to satisfy the required quantity of goods or services at each destination centre by minimizing the total cost of transportation and time of delivery.

Often, the steps involved in transportation problem are to:

(i) Formulate the problem and arrange the Data in the Matrix form,

(ii) Obtain an initial basic feasible solution;

(iii) Test the initial solution for optimality; and

(iv) Updating the solution.

Common methods for finding initial solution include: North-west corner method, Row Minima Method, Column Minima Method, Least-cost Method, and Vogel's Approximation Method. In some cases, a problem of degeneracy may develop. Handling such problem depends on the experience of the decision-maker (Etim, Confidence and Obot, 2022).

2.1.2. Inventory Model

Inventory is any kind of resource with an economic value and is maintained to fulfil the present and future needs of an organization. According to Sharma (2010), Inventory of resources is held to provide desirable service to customers (users) and to achieve sales turnover target. As used in this study, we refer to inventory as items stocked in demand for sales to customers either on wholesale and/or retail.

Much more emphasis is today placed on inventory control because inventory constitutes relatively 70% to 80% of cost of production or sales. Large amounts of capital investment are locked up in inventory of materials. This is why most manufacturing organizations put in place to ensure as far as possible that inventory costs are minimized towards maximization of profit. It is, therefore, essential to balance the advantages of having inventory of resources and the cost of maintaining it so as to determine an optimal level of inventory of each resource (Farounbi, 2005; Sharma, 2010).

Inventory model basically focus on what items should be stocked, when should an order be placed to replenish inventory, and how much should be ordered in each replenishment. It is categorized into two: inventory cost control and inventory physical control. Inventory cost control deals with policies and procedures established to ensure inventory costs are at reasonable levels to enable the organization to attain its goals. Inventory physical control is about

arrangement of inventory in the warehouse and how to issue inventory with the intention of minimizing costs.

The establishment of inventory levels (Economic order quantity, maximum inventory level, minimum inventory level, Re-order level, buffer level, etc) is very pertinent in inventory model.

Transportation and inventory models help in decision making process in a way that identify the factors influencing the decision and as well as quantifying them. It makes it easier to resolve the complications of decision making (Opoku, Fiati, Kaku, Ankomah & Fusina, 2020).

2.1.3. Manufacturer Representatives Firms Operations and Performances

Manufacturer representatives' firms are entities engaged in the provision of logistics and warehousing services to major manufacturing companies whose factories and plants are located distance apart but aimed at ensuring effective coverage of the market and demand space for their products. The Operations and performance of these firms is their ability to accomplish the intermediary role between the manufacturers and the users of the goods at the night place, quantity, time and appropriate price as well as value. The performance of these firms is measured based on decision made at ensuring adequacy of goods inventory items through appropriate transportation and inventory policies.

2.2. Theoretical Review

We adopt the contingency based theory for the study. The development of contingency approach was stimulated by managers, consultants and researchers who tried to apply the concepts of the major Schools of Management to real-life situations. They often found that methods that were highly effective in one situation would not work in other situations. They discovered that a technique that works in one case may not necessarily work in all cases because of differences in their respective situations. They then sought an explanation for these experiences which brought about the contingency based theory. The theory draws the ideas that there is no one or single best way or approach to manage organizations and situations.

Organizations should then develop management strategy based on the situation and condition they are experiencing. Contingency theory tries to identify and measure the conditions under which things will likely occur. Since human services practice various substantially, contingency theory offers a useful approach to modeling and predicts contingency approach practice.

Contingency theory allows one to analyze a situation and determine what variables influence the decision with which a situation is concerned. This is how the theory is related to this study.

2.3. Empirical Review

Related studies reviewed are summarized in the table that follows to ascertain the gap that necessitated the conduct of the present study.

Table 1: Summary of Empirical Studies Reviewed

S/N	*Author(s)*	*Topic/main objective*	*Method of Study*	*Major findings*
i.	Anene and Oyelere (2014)	Evaluation of the application of quantitative techniques of production planning and control in manufacturing industries	Survey research design involving use of questionnaire to obtain data which were analyzed using Tabulation and percentages	Results shows extensive adoption of QT models by manufacturing companies
ii.	Onukwuli *et. al.* (2014)	Application of quantitative techniques in small business management in Sub-Saharan African State	Survey research design using questionnaire to gather data. Data were analyzed using Z-Test statistic	The results revealed that there was no significant variation between business decision areas and QT applications
iii.	Monday *et. al.* (2015)	Strategic management techniques and firm performance: A study of selected manufacturing companies in Nigeria	Use of five-point Likert scale questionnaire to collect data. ANOOA and correlation analysis unemployed to analyzed data	Result showed that strategic management techniques had significant effect on the profitability and operational performance of the selected companies
iv.	Fuller (2015)	Strategist's score-keeper: A quantitative approach to the assessment of business strategies.	Review of previously published taxonomy on quantitative techniques in business management	Reviewed published papers should mixed findings
v.	Etim, Emmanuel and Usen (2022)	Adoption of quantitative techniques and performance of selected quoted manufacturing companies in Nigeria	Survey research design using questionnaire to collect data. Analysis of data involved correlation and simple regression analysis	Result shows selected QT tools had positive and significant influence on performance of select company.

S/N	*Author(s)*	*Topic/main objective*	*Method of Study*	*Major findings*
vi	Etim, Nsima and Ihenyen (2022)	An assessment of the challenges of adoption of quantitative models in decision making by SME s in Nigeria	Primary data study involving analysis of data using descriptive statistics	Finding revealed weak adoption of QT models due to complexities and lacks of understanding of their relevance
vii.	Etim, Confidence and Obot (2022)	Application of quantitative Techniques and performance of SMEs in Nigeria	Quasi-experimental study involving descriptive and inferential statistical analysis	Results revealed adoption of few QT models such as BEA, forecasting which significantly affected performance.

Source: Researchers' Compilation (2022).

2.4. Gap in the Literature

From the reviewed empirical literature for the study, it is clear that no researcher examined specific quantitative technique models as they affect operations and performance of caste firms such as manufacturer representatives and the unique models peculiar to their operations. These study hap on the gap to add to literature on quantitative management practice.

3. RESEARCH DESIGN

The conduct of this kind of research called for the application of survey research design due to the fact that the data collection method required the designing of an instrument (questionnaire) to obtain the relevant data.

3.2. Population and Sample of the Study

The population of the study consisted of all manufacturer representatives' firms in Uyo, metropolis, the capital of Akwa Ibom State. These include manufacturer representatives for drinks, confectionaries, baking consumable, cement, building materials, lubricants, and among others. From our extensive search across the length and breadth of Uyo, we recorded one hundred and twenty-two of such entities which where operational at the time of the study. Thus, the population of this study was one hundred and twenty-two (122).

For the fact that the researchers were able to reach out to the entire population, this number constituted the sampled for the study. This makes the study a census study.

3.3. Sources of Data and Data Collection Method

Data for the study were purely primary collected using a questionnaire designed and score in Likert format with assigned scores as Strongly Agreed (SA) 5 Points, Agreed (A) 4 Points, Disagreed (D)3 Points, strongly disagreed (SD) 2 Points, and Undecided (UD) 1 point.

3.4. Description and Measurement of Variables of the Study

The key variable were performance decision making variable as the dependent variable while the transportation and inventory models components formed the independent variables. These were presented on Table 2 together with the respective *apriori* expectations.

Table 2: Description and Measurement of Variable

S/N	*Variables*	*Abbrev.*	*Measurement*	*Apriori Expectation*
1	Performance	PF	Five point Likert scale	
2	Transportation model	TM	Five point Likert scale	+
3	Inventory Model	InM	Five point Likert scale	+

Source: Researchers Compilation (2022).

3.5. Model Specification

The empirical models were stated appropriately in line with the variable in each of the objectives of the Study:

$$PF = \beta_0 + \beta_1 TM + U_t \qquad \text{Model 3.1}$$

$$PF = \beta_0 + \beta_2 InM + U_t \qquad \text{Model 3.2}$$

Where;

β_0 = regression intercept of PF

β_1, β_2 = Coefficients of Independent Variables

U_t = Random error tem

3.6. Method of Data Analysis

Data collected were analyzed using descriptive and inferential statistics. Descriptive statistics are employed to evaluate the nature of the data obtained and the influential statistic to establish the effect of quantitative technique models in used by the entities studied operations and performance.

4. DATA ANALYSIS, FINDINGS AND DISCUSSION.

Data collected were analyzed using appropriate statistical tools.

4.1. Reliability Test

Cronbach's alpha reliability test are presented on Table 3a and 3b.

Table 3a: Reliability Statistic

No of items	*Cronbach's Alpha coefficient*
16	0.977

Source: Researchers Competition (2022)

Table 3b: Summary of items statistic

Items	*Scale mean if item Deleted*	*Scale variance if item Deleted*	*Corrected item total correlation*	*Cronbach's Alpha if item Deleted.*
PF51	68.3934	71.811	0.960	0.974
PFT2	68.3770	71.757	0.966	0.974
PFE3	68.3934	72.489	0.936	0.975
PFCR4	68.2787	73.690	0.899	0.976
TMNWCM1	68.3443	72.690	0.917	0.975
TMLCM2	68.3607	75.009	0.809	0.977
TMLVAM3	68.3607	72.745	0.910	0.975
TMCMM4	68.4262	69.056	0.941	0.975
TMRMM5	68.5738	66.147	0.877	0.978
TMRT6	68.4918	67.095	0.900	0.976
INEOQ1	68.3607	70.679	0.887	0.975
INMAX2	68.3770	70.600	0.894	0.975
INMin 3	68.1311	76.247	0.775	0.977
IN Rol 4	68.1639	75.841	0.796	0.977
IN BSL 5	68.0984	76.751	0.745	0.978
IN OPC6	68.1475	79.028	0.785	0.977

Source: Researchers' Computation (2022)

Table 3: Disclosed the Cronbach's Alpha Statistic of 97.7% which showed that the data collected from the respondents with questionnaire scaled in Likert format is reliable for use in the study.

4.2. Descriptive statistics

In examining the nature of the collected data, the descriptive statistics for the Variable of Performance, (PF), Transportation Model (TM) and Inventory Model (InM) were computed and presented on table 4.

Table 4: Descriptive statistic for variables

Variable	*N*	*Range*	*Max*	*Min*	*Mean*	*Std.*
Performance	122	1.00	5.00	4.00	4.7500	0.4191
Transportation model	122	2.00	5.00	3.00	4.5246	0.5690
Inventory model	122	4.00	5.00	1.00	4.4344	0.8231

Source: Resources' computation (2022)

From Table 4, performance (PF) had range of 1.00 indicating that the difference between the highest and lowest score in respect to performance in the study was 1.00. The minimum was 4.00, maximum 5.00, mean 4.750 and standard deviation was 0.4191, indicating that the deviation from mean that occurred for performance of manufacturer representatives firms studied was not high. That is, fluctuation in the performance is minimal among the firms.

Transportation Models (TM) had a range of 2.00 indicating that the difference between the highest and the lowest values in respect to transportation models adoption. The maximum score was 5.0 and minimum 3.0, while the average (mean) was 4.52 with a standard deviation of 0.5690, indicating a minimal variation or fluctuation in adoption of transportation models by these firms.

On inventory models, we recorded a range of 4.00, indicating the difference between the highest and lowest score in respect to inventory models adoption by the manufacturer representative firms. The maximum was 5.00, Minimum 1.00, average (mean) score of 4.4344 with standard deviation of 0.8231 indicating minimal variations in the usage of inventory models by these business managers.

4.3. Correlation Matrix

To assess the relationship between the dependent and independent variables, the correlation coefficients were computed and persecuted on table 5.

Table 5: Correlation matrix and multicollinearity check

Variable	*PF*	*TM*	*INM*
Performance	1.000		
Transportation model	0.762	1.000	
Inventory model	0.713	0.058	1.00

Source: Researchers' Computation (2022)

From the result, the relationship between PF and Transportation Models (TM) was 76.2% and between PF and inventory model was 71.3%. This

implies a strong positive correlation between the dependent and independent variables. It was also seen that the correlation between TM and INM, the two independent variables was 5.8% less than 60% indicating absence of multi- co linearity in the model.

4.4. Analysis of Research Questions

The research questions of the study which were stated in accordance with the objectives were analyzed using linear regression statistical tool in line with the stated models of this study.

4.4.1. Research Question One

Does the adoption of transportation model have any significant effect on the operations and performance of manufacturer representative firms in Akwa Ibom State?

The simple linear regression analysis was conducted and presented on Table 6.

Table 6: Simple Linear Regression Output for Research Question one

variable	*Beta (B)*	*t-stat*	*p-value*	*Remark*	*R*	*R*	*F-ratio*
Constant	2.209	11.137	0.000	Sig.	0.762	0.580	166.66
TM	0.742	5.791	0.000	Sig.			Prob.< 0.05

Dependent variables = PF

Source: Researchers' Computation (2022).

From Table 6, the coefficient of determination (R^2) showed that 58% variation in the performance of manufacturer representative firms in Akwa Ibom State was caused by the influence of transportation models adoption in the shipment of goods from production to the demand centres. More so, the result shows that TM had positive and significant influence on performance of these firms because both the t-stat and p-value indicated that TM is significant. The F-ratio of 166.66 (Prob.< 0.05) indicated that R^2 was significant in explaining the model. The findings were in line with the *apriori* expectation. It was, therefore, concluded that adoption of transportation model has significant effect on the operations and performance of manufacturer representative firms in Akwa Ibom State.

4.4.2. Research Question Two

What is the effect of the adoption of inventory models on the operations and performance of manufacturer representative firms in Akwa Ibom State?

The simple linear regression analysis was conducted and presented on Table 7

Table 7: Simple Linear Regression Output for Research Question Two

Variable	*Beta (B)*	*t-stat*	*p-value*	*Remark*	*R*	*R*	*F-ratio*
Constant	3.141	21.365	0.000	Sig.	0.713	0.508	123.94
InM	0.629	22.278	0.000	Sig.			Prob.< 0.05

Dependent Variables = PF
Source: Computed by Researchers (2022)

Table 7 showed the simple linear regression result for inventory models. The coefficient of determination (R^2) was 50.8% explaining that variation in performance and operations of manufacturer representative firms in Akwa Ibom State was attributed to this variable. The F-ratio of 123.94 (Prob.< 0.05) means that R^2 was significant in explaining the effects of inventory model on operations and performances of these firms under study. InM indicated positive and significant effects on PF (t.stat 1.966; P-value < 0.05). It implied that a percentage increase in InM resulted to 62.9% increase in operational activities and performance for the period of the study.

The result of the analysis was in line with the *apriori* expectations and the constant value of 3.41 means, if all factors are held constant, PF was positive with the 3.141 value point. We, therefore, concluded that adoption of inventory models had positive effect on the operations and performance of these firms in Akwa Ibom State.

4.5. Discussion of the Findings

From the analyses, it has been discovered that the variables studied (Transportation and Inventory models) had a positive and significant effect on the operations and performance of manufacturer representative firms in Akwa Ibom State.

The transportation model sub-components used were the North-West-Corner Method (NWCM), Least- Cost- Method (LCM), Vogel's Approximation method(VAM), Column Minima method (CMM), and Row minima method (RMM), as well as handling of degeneracy issues. The study findings are not in line with those of Onukwuli. *et. al.* (2014) and Fuller (2015) who reported negative effects of transportation models on the operations of Small and Medium Scale Enterprises (SMEs) in sub- Saharan African- State as

well as minimal adoption of transportation models by selected manufacturing companies in Nigeria, unlike our findings which reported positive effects and influence.

In the same vein, Inventory model sub-components included in the questionnaire were Economic Order Quantity (EOQ), Maximum Inventory Level (MAXL), Minimum Inventory Level (MINL), Re- Order Level (ROL) Buffer inventory level (BL), and optimal cost (OP) strategies. The result of the data analysis; inventory models had a positive and significant influence on the operations and performance of the studied firms. This finding is in line with earlier findings of Anene and Oyelere (2014) and Monday *et. al.* (2015) who conducted a study on evaluation of the application of quantitative techniques to production planning and control in manufacturing industries, but at variance with those of Etim *et. al.* (2022) who investigated challenges of adoption of QT models by selected companies in Nigeria, and reported negative effects.

5. CONCLUSION AND RECOMMENDATIONS.

5.1. Conclusion

The investigation was carried out to ascertain the effects of the application of transportation and inventory models on the operation and performance of manufacturer representative firms in Akwa Ibom State. Fundamentally, the nature of operations of these firms required application of quantitative models in decision making given the volatile and complexities in modern business environment, which call for more advanced management techniques. The result of analysis showed these models are positively and significantly relevant to their operations.

5.2. Recommendations

From the findings, the following recommendations are made:

(i) Trans-shipment problem should problem should be studied to handle transportation hurdles should that be the case to minimize shortages of products.

(ii) Least-Time problems and lead-time lag should be carefully studied to handle issues of delay supplies.

(iii) Computerization of Operations is also recommended so as to use software for more robust applications of quantitative models which seem sophisticated to handle manually.

(iv) Forecasting Models should also be applied along with the models studied for a holistic decision making and planning horizon by these categories of organizations.

5.3. Suggestion for further studies

Further researches can be extended to other quantitative models such as assignment model, queuing models in handling order placement, forecasting on the operations and performance of these business entities and even extending coverage across regions.

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