Effect of Transportation Model on Organizational Performance: A Case Study of MTN Nigeria, Asaba, Delta State, Nigeria

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ABSTRACT
Transportation cost plays an important role in location. As a result they are operating blindly, instead of seeking for the services of qualified statistician. This paper therefore, examined the extent to which the use of transportation model affects the growth of the organisation among others objectives. This paper makes use of both primary and secondary sources of data. The survey method with questionnaire as the instrument was used to determine responses from respondents. Pearson product moment correlation analysis was used to test the hypotheses. It was discovered from respondents that the use of this model has contributed to the growth of the organisation. In addition, the study revealed that transportation model can lead to minimum total shipping cost. The study concluded by saying that half hazard distribution of resources (products) can be counter productive. It is in fact, uneconomical and as a result the need for a scientific application cannot be overemphasized. Among others, the study recommended that transportation model should be employed in the distribution of the products of organisations in Nigeria.

Keywords: Transportation model, minimum total shipping cost, time utility, products, degeneracy.

INTRODUCTION
Mathematical optimization is the branch of computational science that seeks to answer the question, what is “best” for problems in which the quality of any answer can be expressed as a numerical value. Such problem arises in the area of business, physical, chemical, and biological sciences, engineering, architecture, economics and management. The ranged of techniques available to solve them is wide. Because location of a new factory, warehouse, or distribution centre is a strategic issue with substantial cost implication, most organisations in Nigeria consider and evaluate several locations. With a wide variety of objectives and subjective factors to be considered, rational decisions are aided by a number of techniques. One of those techniques is transportation modelling.

The use of transportation model to minimise the cost of shipping from a number of sources to a number of destinations was first proposed in 1941 (Srinivasan, 2010). This study, called the distribution of a product from several sources to numerous localities was written by Fithcock F.L. Six years later Kooprnans T.C. independently produced the secured major contribution, a report entitled “optimum utilization of the transportation system”.

To Chase and Aquilano (2000) transportation method is a simplified special case of the simplex method of linear programming. Transportation model deals with special class of linear programming problems in which the objective is to transport a homogenous commodity from various origins to different destinations at a minimum cost.
Transportation model can also be used when a firm is trying to decide where to locate a new facility or sales office. It is a good practice to consider a number of alternative sites. Anderson and Lievano (2005) noted that certain linear programming problems arise that exhibit various special features. According to them, one of such types of problems is the transportation problem. As a result of the special nature of these problems, algorithms are available for solving them. This computational method is more efficient than the simplex method.

According to Buffa (2002), distribution (transportation) methods of linear programming developed around the classical problem of distributing goods from a set of origin points to multiple destinations at a minimum cost. He noted that the basic problem can be formulated and solve in the simplex format but that a special methodology have been developed which is simpler and easier to understand and very importantly is computationally faster.

In addition to minimizing the cost of distributing goods, this model can also create time utility.

THEORETICAL FRAMEWORK

Transportation Concepts
The objective of the transportation algorithm is to determine the best plan of assigning the units from each origin to specific destination so that the overall plan of transporting the goods minimizes the total cost. As with most operations research concepts, there is an initial procedure, which is the first feasible solution. It will be followed by an interactive process.

A general transportation model with m sources and n destinations has \( m+n \) constraints equations, one for each source and one for each destination. But because the transportation model is always balanced (sum of the supply equals sum of the demand), one of these equations is always redundant. Hence the model has \( m+n-1 \) independent equations. The implication of this is that the starting solution has \( m+n-1 \) basic variable (Hamburg 1998).

North –West Corner Method
This method makes allocation from the North West corner cell.

The steps are:

- Allocate as much as possible to the selected cell and adjust the associated amounts of supply and demand by subtracting the allocated amount.
- Cross out the rows or columns with zero supply or demand to indicate that no further assignments are possible in such row or column. Should both row and column be net zero at the same time, cross out one only and leave a zero supply (demand) in the uncrossed out row (column).
- If exactly the row or column is left uncrossed out, stop. Otherwise move to the cell to the right if a column has just been crossed out (Lapin 2000).

Least Cost Method
This method finds a better starting solution by concentrating on the cheapest routes. The method starts by assigning as much as possible to the cell with the smallest unit cost. The satisfied row or column is crossed out and amount of supply and demand are adjusted accordingly. If both a row and a column are satisfied and at the same time only one is crossed out, the same way as in the uncrossed cell with smallest unit cost is sought and the process is repeated until exactly one row or column is left uncrossed out (Mood and Graybill 2000).

Vogel Approximation Method
Vogel approximation method is an improved version of the least cost method that generally produces better starting solutions. The Vogel’s approximation method makes possible a very good initial solution. The technique is a simple one and reduces considerably the amount of work required to develop a solution.

The steps in determining an initial Vogel’s approximation method solution are as follows (Taha, 2005). 

- Determine the difference between the two lowest distribution costs for each row and each column.
- Select the row or column with the greatest difference.
Assign the largest possible allocation within the restrictions of the rim condition to the lowest cost square in the row or column selected.

Cross out any row or column completely satisfied by the assignment just made.

Recalculate the differences as in step (a) except for rows or columns that have been crossed out.

Repeat steps (a) to (c) until all assignments have been made (Neter and Whitemore 1990).

The Stepping-Stone Method
Bradley (1980) asserts that the stepping stone method is about moving from an initial feasible solution to an optimal solution. It is used to evaluate the cost effectiveness of shipping goods via transportation routes not currently in the solution. When applying it, test each unused cell, or square, in the transportation table by asking: what would happen to total shipping costs if one unit of the product was tentatively shipped to an unused route.

The Steps are as Follows:
  • Select any unused square available.
  • Beginning at this square, trace a closed path back to the original square via squares that are currently being used (only horizontal and vertical moves are permissible). You may, however, step over either an empty or an occupied square.
  • Beginning with a plus (+) sign at the unused square, place alternatively minus signs and plus signs on each corner square of the closed path just traced.
  • Calculate an improvement index by first adding the unit cost figures found in each square containing a minus sign.
  • Repeat step 1 through 4 until you have calculated an improvement index for all unused squares. If all indices computed are greater than or equal to zero, you have reached an optimal solution. If not, the current solution can be improved further to decrease total shipping cost.

Another method for testing optimality is called the modified distribution method (MODI). This method is based on the concept of dual variables, which are used for evaluating the empty cells of a given programme. This method is a simple way of assigning values to the dual variables associated with a given solution. Once this is done, the opportunity cost of the empty cells of a programme can easily be calculated. As compared to the Stepping-Stone method, the MODI method of testing optimality is simple and more efficient.

Special Issues in Modelling
Demand not equal to supply
A common situation in real world problems is the case in which total demand is not equal to total supply. This problem can be handled by introducing dummy sources or dummy destination. If total supply is greater than total demand, this will make demand exactly equal the surplus by creating a dummy destination. Conversely, if total demand is greater than total supply, we introduce a dummy source(factory) with a supply equal to the excess of demand. Because the units will not in fact be shipped, assign cost coefficient of zero to each square on the dummy location. In each case than the cost is zero (Service 1990).

Degeneracy
According to Klecka and Hull (2000) degeneracy is the term use to describe a plan for transportation model which arises when the number of routes used does not satisfy the rule. This means that the number of occupied cells in a given transportation programme is less than the number of rows and columns in the transportation matrix. Whenever the number of occupied cell is less than $m+n-1$, the transportation problem is said to be degenerate.

To apply the stepping stone method to a transportation problem, an important rule about the number of shipping routes being used must be observed. The number of occupied squares in any solution (initial or later) must be equal to the number of row in the table plus the number of columns minus 1. Solutions that do not satisfy this rule are called degenerate.
Rationale of Transportation Model
The transportation model, a form of linear programming, is used to help find the least cost solutions to system wide shipping problems. The North West corner method (which begins in the upper-left corner of the transportation table) or the intuitive lowest-cost method may be used for finding an initial feasible solution. The importance of this model cannot be over emphasized. But the fact is that most organisations in Nigeria do not apply this model in their operations. In fact, there are software packages that have been developed to make the use of the model easier. Software like Excel, Excel om and Pom for windows may be used to solve transportation problems (Buffa, 2002). The transportation model is a valuable tool in analysing and modifying existing transportation systems or the implementation of new ones. The model is effective in determining resources allocation in existing business structures. The model requires a few key pieces of information which include the following:
- Origin or the supply
- Destination of the supply
- Unit cost to ship

The transportation model can also be used as a comparative tool for providing business decision makers with the information they need to properly balance cost and supply. The use of this model for capacity planning is similar to the model used by engineer in the planning of waterways and highways. This model will help decide what the optimal shipping plan is by determining a minimum cost for shipping from numerous sources to numerous destinations. This will help for comparison when identifying alternatives in terms of their impact on the final cost for a system. The application of transportation model includes location decisions, production planning, capacity planning and transshipment. Nonetheless, the major assumptions of the transportation model are the following:
- Items are homogenous
- Shipping cost per unit is the same no matter how many units are shipped.
- Only one route is used from place of shipment to the destination.

Through the use of this model, decision makers can also create time utility by getting the goods at the right place on time (Taha, 2005).

Statement of the Problem
Transportation model play an important role in location decision. Most organisations in Nigeria do not apply this model when it comes to the distribution of stocks of goods or supplies from multiple origins to multiple destinations that demand the goods. This is because they are not aware of the benefits derived from its usage. Most organizations are operating blindly instead of seeking for the services of qualified statistician. This has led to increase in cost of transportation and reduced profit.

Objectives of the Study
The broad objective is to determine the effect of transportation model in Nigeria business organisation. This study intends to achieve the following objectives.
- To examine the extent to which the use of transportation model affects the growth of the organisation.
- To ascertain the extent to which the use of transportation model leads to minimum total shipping cost.
- To determine the extent to which the use of transportation model creates time utility.

Research Questions
- Does the use of transportation model affect the growth of the organisation?
- To what extent does the use of transportation model leads to minimum total shipping cost?
- Does the use of transportation model create time utility?
RESEARCH METHODS
This paper made use of both primary and secondary sources of data. The survey method with questionnaire as the instrument was used to determine responses from respondents. Secondary data was used to obtain comprehensive review of literature related to the subject. The population was MTN Asaba with a staff strength of 200. To determine the category that will make the sample size, purposive sampling techniques was used to arrive at 90 staff both management staff and non management staff. Pearson product moment correlation analysis was used to analyse the data.

Data Analysis
1 – 5 point Likert scale was used with the following response categories.
Strongly Agree (SA) 5 points
Agree (A) 4 points
Undecided (UD) 3 points
Disagree (D) 2 points
Strongly Disagree 1 point
The formula for Pearson product moment correlation analysis is

\[ r = \]

RESULTS

Table 1 Calculation of Pearson product moment correlation analysis

<table>
<thead>
<tr>
<th>Options</th>
<th>X Points</th>
<th>Y Responses</th>
<th>XY</th>
<th>X²</th>
<th>Y²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>5</td>
<td>45</td>
<td>225</td>
<td>25</td>
<td>2025</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
<td>30</td>
<td>120</td>
<td>16</td>
<td>900</td>
</tr>
<tr>
<td>Undecided</td>
<td>3</td>
<td>68</td>
<td>24</td>
<td>9</td>
<td>64</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>90</strong></td>
<td><strong>381</strong></td>
<td><strong>55</strong></td>
<td><strong>3018</strong></td>
</tr>
</tbody>
</table>

Source: Field work, 2018.

\[ r = \]

\[ r = 0.9388 \]

The above result does show that transportation model affects the growth of organisations.

Table 2 Calculation of Pearson product moment correlation analysis

<table>
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<tr>
<th>Options</th>
<th>X Points</th>
<th>Y Responses</th>
<th>XY</th>
<th>X²</th>
<th>Y²</th>
</tr>
</thead>
<tbody>
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<td>200</td>
<td>25</td>
<td>1600</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
<td>35</td>
<td>140</td>
<td>16</td>
<td>1225</td>
</tr>
<tr>
<td>Undecided</td>
<td>3</td>
<td>10</td>
<td>30</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>Disagree</td>
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<td>3</td>
<td>6</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>90</strong></td>
<td><strong>378</strong></td>
<td><strong>55</strong></td>
<td><strong>2938</strong></td>
</tr>
</tbody>
</table>

Source: Field work, 2018

\[ r = \]

\[ r = 0.9407 \]

The above result does show that the use of transportation model does leads to minimum total supply cost.
Table 3 Calculation of Pearson product moment correlation analysis

<table>
<thead>
<tr>
<th>Options</th>
<th>X Points</th>
<th>Y Responses</th>
<th>XY</th>
<th>X²</th>
<th>Y²</th>
</tr>
</thead>
<tbody>
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<tr>
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<tr>
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<tr>
<td>Strongly disagree</td>
<td>1</td>
<td>01</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
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<td>90</td>
<td>397</td>
<td>55</td>
<td>3550</td>
</tr>
</tbody>
</table>

Source: Field work, 2018.

\[ r = \]
\[ r = \]
\[ r = 0.9141 \]

The above result does show that use of transportation model does creates time utility.

DISCUSSION OF FINDINGS
The importance of the use of transportation model in an organisation cannot be overemphasized. The study revealed that the use of this model has contributed to the growth of the organisation. It has enabled organisations to distribute its products. Agbadudu (1996) opines that this model will assist organisations in finding the best use of their limited resources in such a way that it will lead to the growth of their firms. It was also gathered that the use of this model assist the organisation in minimising the cost of distributing their products. Cochran (1990) avers that the use of this model has enable organisations to minimise the cost of distributing their products, the conclusion was reached after a study he embarked in New York. The study revealed that firms that made use of this model recorded low cost in the distribution of their products, while those that did not use it recorded high cost in the distribution of their products. Time utility was also another advantage of using the model. Buffa (1990) is of the view that this model creates time utility. It enables organisations to decide where to locate a new facility or sales office that will be easily assessable to its customers which invariably will lead to increased productivity.

CONCLUSION
In this work we have discussed the background of transportation problems. The study also discussed the various methods of solving transportation problems vis the north west corner method, the least cost method and others. It has been observed that haphazard distribution of resources (or products) can be counter productive. It is in fact uneconomical. The need for a scientific application cannot be over emphasized. The objective of the transportation algorithm is to determine the best plan of assigning the units from each source (or origin) to specific destinations so that the overall plan of transporting the goods minimises the total cost.

It has been found that randomly distributing products is not economical at all.

RECOMMENDATIONS
The following are the recommendations.
1 Transportation model should be employed in the distribution of the products of organisations in Nigeria.
2 Government parasatals and other organisations should employ or seek the services of qualified statisticians, instead of operating blindly.
3 Further studies should be taken to see other areas where the transportation model can be applied, like in production inventory location and equipment maintenance.
REFERENCES