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Assessing the Relationship Between Transportation Model and Organizational Performance

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Abstract: *Location is significantly impacted by transportation costs. Some firms are operating without proper planning on the best method for transporting their products. Therefore, this study examined the extent to which the adoption of the transportation model influences time utility, among other factors. In this study, data are gathered from primary and secondary sources. A questionnaire was used as the instrument in the survey method to determine respondents' responses. Pearson's product-moment correlation was used to assess the hypothesis. Respondents disclosed that the organization's growth had been facilitated by the implementation of this practice. The study also demonstrated that a transportation strategy can lead to the most economical overall shipping expenses. Half-hazard resource (product) distribution can be counterproductive. It is actually uneconomical, hence the need for a scientific application cannot be emphasized enough. Among other things, the report recommended that Nigerian firms adopt the use of the transportation model.*

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

Finding the "best" answer to problems where the quality of any particular solution can be measured is the focus of the computational science field known as mathematical optimization. Among the disciplines where these problems arise are business, engineering, architecture, economics, management, and the physical, chemical, and biological sciences. To address them, a variety of strategies might be employed. Most Nigerian companies consider and evaluate several locations when choosing where to build a new factory, warehouse, or distribution center, which is a strategic choice with big financial consequences. Many strategies are used to help make rational judgments

since they need to consider a variety of goals and subjective aspects. One of those techniques is the transportation model.

The concept of employing a transportation model to lower the cost of shipping from several origins to several destinations was first proposed in 1941. (Srinivasan, 2010). It is the distribution of a product from several sources to numerous areas A simplified special case of the transportation approach is the simplex methodology of linear programming (Chase and Aquilano 2000). The transportation model tackles a specific category of linear programming problems in which the objective is to deliver a uniform good between several origins and destinations at the lowest feasible cost.

The transportation model can also be used by a business to decide where to locate a new production office or facility. Thinking about multiple websites is a smart idea. Certain problems involving linear programming have special features, one of which concerns the transportation problem. (Anderson and Lievano 2005). There are algorithms to address these problems since they are distinct. This computational method is more efficient than the simplex method.

The traditional challenge of distributing goods from a group of origin points to numerous destinations at the lowest possible cost was the basis for the creation of linear programming distribution techniques (Buffa, 2002). The essential problem may be expressed and solved using the simplex style, but a special approach that is simpler, easier to understand, and most importantly faster in processing has been developed. In addition to lowering the cost of distribution, this model can also lead to time utility.

A major factor in the location decision is the transportation model. Most Nigerian companies do not employ this approach when it comes to moving inventory or supplies from different sources to different places where the goods are required. Their lack of knowledge about the benefits of using it has led to increase of running their firms. Most businesses are operating in the dark rather than doing the needful. As a result, shipping costs have increased, and profit has decreased. This work is intended to close this gap.

The primary objective is to ascertain how the transportation model affects corporate entities in Nigeria. These specific objectives are to determine the degree to which using a transportation model results in the lowest possible overall cost of shipment to examine the extent to which the transportation model use generates time utility

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LITERATURE REVIEW

The transportation algorithm's goal is to minimize the total cost of the items' transportation plan by determining the most effective method of allocating the units from each origin to a certain destination. Most topics in operations research include the first workable solution or initial procedure. Thereafter, there will be an interactive process.

A typical transportation model with m sources and n destinations has restrictions for each source and destination, which sum up to m+n. However, one of these equations is never required because the transportation model (the total of supply and demand) is always balanced. As a result, the model contains m+n-1 independent equations. This implies that there is m+n – 1 basic variables in the starting solution (Hamburg1998).

The Northwest corner cell is used for allocation in this method.
The steps are:

1. Give as much as you can to the selected cell, then take away the allotted amount to change the matching supply and demand amounts.
2. Show that no additional assignments can be made in a row or column by crossing it out if there is no supply or demand. Only one row should be crossed out if both rows and columns are net zero at the same time, leaving the uncrossed-out row with zero supply (demand) (column).
3. If a certain row or column is still uncrossed, stop. However, go on to the cell on the right if a column has lately been crossed out (Lapin 2000).

This method finds a better initial solution by concentrating on the least expensive routes. First, as much as possible is given to the cell with the lowest unit cost. The crossed-out row or column, which represents the satisfied client, is used to adjust the quantity of supply and demand. If only one row or column is crossed out at a time and both are satisfied, the process is repeated until exactly one row or column is left uncrossed out. This is comparable to the least expensive uncrossed cell per unit (Mood and Graybill2000).

The Vogel approximation method, which is an improved version of the least-cost approach, usually produces better initial results. Vogel's approximation method makes a very excellent first answer possible. The approach is simple and drastically reduces the amount of work required to find a solution.

The following are the steps to determine an initial answer using Vogel's approximation method: (Taha, 2005).

1. Determine how the two lowest distribution costs for each row and each column differ from one another.
2. Select the row or column with the biggest difference.
3. Within the constraints of the rim condition, assign the highest possible allocation to the lowest cost square in the selected row or column.
4. If you are completely satisfied with the work you just finished, mark off any column or row.
5. Use the procedure from step (a) to recalculate the differences, omitting the rows and columns that have been crossed out.
6. Continue steps (a) through (c) until all assignments have been completed (Neter and Whitemore 1990).

Bradley (1980) asserts that the stepping-stone method entails moving from an initial feasible answer to an optimal one. It is used to assess the cost-effectiveness of moving goods via routes that are not yet covered by the solution. When utilizing it, look at each square or unused cell in the transportation table and ask: if one product unit were delivered tentatively to an underused route, how much would shipping cost overall?

The Steps are as Follows;

- Select any unused square available.
- Make a closed route from this square to the original square by utilizing the squares currently in use (only horizontal and vertical moves are permissible). One are free to cross an empty or occupied square, though.
- Beginning with a plus (+) sign at the empty square, place plus and negative signs on each of the corner squares of the closed path in turn.
- Initially, generate an improvement index by adding up the unit cost data from every square with a negative label.
- Proceed with steps 1 through 4 until you have calculated an improvement index for each underutilized square. When every calculated index is greater than or equal to zero, the optimum solution has been reached. Otherwise, there is potential for the current system to be improved in order to reduce the total cost of shipping.

Optimality can also be assessed using the modified distribution approach (MODI). Based on the concept of dual variables, this method is used to evaluate the empty cells in a program. This simple process can be used to assign values to the dual variables associated with a given solution. The potential cost of a program's empty cells may then be easily calculated. Compared to the Stepping-Stone method, the MODI method is more user-friendly and efficient for determining optimality. This is a common situation in real-world problems when total supply and total demand are not equal.

This problem can be resolved by using dummy sources or fictitious destinations. If total supply surpasses total demand, demand will exactly equal the surplus by creating a fictional destination. In contrast, if the total demand is more than the total supply, we construct a dummy source (factory) with a supply equal to the excess demand. Each square on the dummy site should have a cost coefficient of 0 because the units won't be sent. In every case, the cost is zero (Service 1990).

According to Klecka and Hull (2000), "degeneracy" describes a transportation model plan that appears when the number of routes traveled deviates from the norm. There are more rows and columns in the transportation matrix than there are occupied cells in a specific transportation program. The transportation problem is regarded as degenerate when the number of occupied cells is fewer than m+n-1.

When using the stepping stone method for a transportation problem, there is a critical rule about the number of shipping routes that must be followed. The number of occupied squares in any solution—original or later—must equal the sum of the number of rows and the number of columns minus one. Solutions that do not adhere to this criterion are known as degenerate solutions.

The transportation model is a kind of linear programming that helps address system-wide shipping problems by identifying the least costly solutions. Applying the North West corner strategy, which begins in the upper-left corner of the transportation table, or the intuitive lowest-cost method, will yield an initial feasible solution.

The importance of this paradigm cannot be overstated. But in reality, this paradigm is not used in the day-to-day operations of most Nigerian enterprises. In fact, software packages that have been developed make the concept easier to use. Software such as Excel, Excel OM, and Pom for Windows can be used to address transportation-related challenges (Buffa, 2002).

The transportation model is a helpful tool when assessing and modifying existing transportation systems or implementing new ones. In today's organizational systems, the idea is effective for allocating resources.

The model requires a few key pieces of information, which are as follows:

- Origin or the supply
- Destination of the supply
- Unit cost to ship

Business decision-makers can also use the transportation model as a comparison tool to get the information they require to properly balance cost and supply. When engineers plan canals and roadways, they utilize a model similar to this one for capacity planning.

This model will help determine the optimal shipping plan by figuring out the lowest cost of shipping from many sources to multiple destinations. Comparing possibilities to see how they will impact the final cost of a system will be simpler as a result. The application of the transportation model includes site selection, production planning, capacity planning, and transshipment. Nonetheless, the transportation model's primary assumptions are as follows:

- Items are homogeneous
- No matter how much is transported, the delivery cost is the same for all products.
- There is only one route from the cargo site to the destination.

By making sure that the goods get at the right place on time, decision makers can also create time utility with this model (Taha, 2005).

Research Method

For this work, material was gathered from both primary and secondary sources. The survey approach, which used a questionnaire as the instrument, was used to determine the respondents' responses. Using secondary data, a comprehensive examination of the pertinent literature was conducted. Guinness Nigeria PLC employed two hundred workers. To determine the category that will make up the sample size, 90 employees, including management and non-management staff, were reached using purposive sampling techniques. To analyze the data, Pearson product-moment correlation analysis was used.

A 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

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RESULT

Table 1: Calculation of Pearson product-moment correlation analysis

Options	**X Points**	**Y Responses**	**XY**	$\mathbf{X^2}$	$\mathbf{Y^2}$
Strongly agree	5	40	200	25	1600
Agree	4	35	140	16	1225
Undecided	3	10	30	9	100
Disagree	2	3	6	4	9
Strongly disagree	1	2	2	1	4
Total	**15**	**90**	**378**	**55**	**2938**

Source: Fieldwork, 2025

r = 0.9407

The above result does show that the use of transportation model leads to minimum total supply cost.

Options	**X Points**	**Y Responses**	**XY**	$\mathbf{X^2}$	$\mathbf{Y^2}$
Strongly agree	5	48	240	25	2304
Agree	4	35	140	16	1225
Undecided	3	4	12	9	16
Disagree	2	2	4	4	4
Strongly disagree	1	01	1	1	1
Total	**15**	**90**	**397**	**55**	**3550**

Table 2: Calculation of Pearson product-moment correlation analysis

Source: Fieldwork, 2025.

R = 0.9141

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

DISCUSSION OF FINDINGS

The importance of using the transportation model for an organization cannot be overstated. According to the study, employing this practice has led to a minimum total shipping cost. It has enabled companies to systematically circulate their products. Whitemore (2000) asserts that this approach will assist firms in maximizing the utilization of their scarce resources to ensure the prosperity of their enterprises. The application of this method also helps the company to create time utility. Evans-Obinna and Nwosu (2016) assert that this methodology has enabled companies to create time utility with lower distribution costs. Businesses that employed this method reported lower product distribution costs, whereas those that did not reported higher costs, according to their study. They also posit that it enables companies to pick a site for a new facility or sales office that is convenient for their customers to visit, which will undoubtedly lead to increased output. In all, the use of the transportation model is beneficial to the firm.

Conclusion

In this work, we have seen that the importance of using the transportation model cannot be overemphasized. The study also discussed other ways to solve transportation problems, including the north-west corner method and the least cost method. It has been demonstrated that distributing resources (or things) at random has detrimental impacts. In reality, it is not economical. The significance of a scientific application cannot be overstated. To lower the total cost of the items being transported, the transportation algorithm seeks to determine the most effective method of allocating the units from each source (or origin) to certain destinations. It has been demonstrated that random product distribution is utterly inefficient.

Recommendations

The following are the recommendations

1. Nigerian enterprise should leverage the transportation concept when distributing their goods.
2. Qualified personnel should be hired or sought out by government parastatals and other businesses instead of working blindly.
3. There should be more research done on the transportation model in other areas, like manufacturing inventory location and equipment maintenance.

4. Firms or organizations should organize training workshops on the importance of using the transportation model.

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