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MODELLING THE TRANSPORTATION EFFICIENCY OF AN EDUCATIONAL INSTITUTE

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Abstract

The study utilized a model of linear transportation to locate the base expense of moving educational materials from the educational institute (distribution centres) to the branches (request or demand area). The information was analysed using QM software 2013. Consequently, the examination shows that the Northwest corner technique was ₦292,750 000, the minimum cost technique was ₦273,500 000 and Vogel's estimation technique was ₦230,000 000. Based on the outcome Vogel's estimation technique was a proficient technique due to lower cost. The modified distribution method (MODI) was utilized to optimize the techniques to arrive at a final feasible output of ₦230,000,000. The transportation model will enable the organization to distribute educational materials optimally at a transportation cost of ₦230,000 000 via an optimal route.

Keywords: Modified distribution method (MODI), Vogel estimation technique, Northwest corner technique, Minimum cost technique.

1. INTRODUCTION

The transportation of goods comes to play at a cost that does not add any incentive in terms of size, amount, or quality to the product. However, it guarantees the delivery and sale of goods. This expense is borne by either the organization or the client through the increment of transportation cost or the cost of the goods respectively. The cost of transportation varies with the method adopted by the organization and the specific method picked is subject to the qualities of the method and the organization's specifications. In Nigeria, road transportation is the predominant method of movement as it represents about 90% of the inner movement of travellers and cargoes (Edokpia & Amiolemben, 2016). Transportation problem model basically minimizes the

expense of shipping an item from different sources (m) to the desired locations (n). Transportation problem model aims at moving various measures of homogeneous things that are kept at different locations to various demand sites at an absolute transportation cost that is minimal (Ibidunni, Ufua, Okorie, & Kehinde, 2019; Aliyu, Usman, Babayaro, & Aminu, 2019).

According to Juman and Nawarathne (2019), there are three fundamental procedures to obtain an underlying basic solution in transportation problem model they are Northwest corner method, the minimum cost technique, and Vogel's estimation technique. Meanwhile, the key procedures acquire a near optimal solution is the stepping stone strategy and modified distribution technique (Ogunnaike, Bishop, Akinsulire, Kehinde, & Oreagba 2018; Adebayo, Kehinde, Ogunnaike, Olaoye, & Adesanya, 2019). The study utilized Vogel's estimation technique, the least cost technique, Northwest corner method, and the modified distribution approach, to optimize the transportation cost and determine the optimal course.

2. LITERATURE REVIEW

Radthy, Maghool, and Khaleel (2019) applied the base cell cost strategy and Vogel estimation technique in a domestic food company. The initial solution obtained is evaluated utilizing the stepping stone test so as to get the ideal solution. A significant aspect of linear programming is transportation model however; a methodology was engaged by Ghadle and Munot (2019) to improve the current solution with advances using a fuzzy transportation model. An inventive hypothesis was discussed by Sumathi and Bama (2019) to attain an optimal cost in transportation using Vogel's estimation technique and the modified distribution method (MODI). Singh, Pradhan, and Biswal (2019) stated that a three-dimensional transportation issue is an unstable multi-objective dynamics (MODM) issue. Specifically, it includes scanning for the best transportation set-up that meets the management inclinations by considering the clashing goals/measures. The study proposed a general definition of the multi-objective transportation issue with some irregular boundaries using fuzzy transportation problem model. A straightforward methodology was proposed to obtain the best answer for the linear multi-objective transportation issues. A proficient feasible output was obtained by the proposed approach additionally, this methodology is easy to utilize and less tedious (Kaur, Rakshit, & Singh, 2018).

A reasonable goal for appropriating the items in the chosen area has been picked cautiously based on the request and least rent of the distribution centres. Banik and Hasan, (2018) formulated a mathematical transportation model and the iteration was carried using 'C' programming language utilizing Vogel's technique. The feasible solution indicated that the optimal measure of supply with the relating location in demand.

3. JUSTIFICATION FOR THE STUDY

An educational institute in Lagos intends to move educational materials such as textbooks to its various branches within the metropolis. However, the advent of covid 19 has caused a major disruption in transportation. As a result the cost of transportation is high. In other to overcome this bottleneck the determination of an optimal transportation course is very important. While, the minimization of transportation cost to augment profitability is key. In this manner, there is a need to obtain an appropriate mechanism for conveying educational materials at a limited transportation cost to the chosen location based on request and supply. Therefore, the study mathematically investigates and provided ways to minimize transportation cost and select an optimal route.

4. OBJECTIVE OF THE STUDY

The objective of the study is to minimize transportation cost and determine an optimal route utilizing transportation problem model such as Vogel's estimation technique, minimum cost technique, Northwest corner method and modified distribution (MODI) algorithm.

5. METHODOLOGY

Minimize $z = \sum_{i=1}^m \sum_{j=1}^n C_{ij}X_{ij}$ Objective Function

$$\sum_{j=1}^n X_{ij} \leq a_i, i= 1,2,3.....m \quad (\text{Request})$$

$$\sum_{j=1}^n X_{ij} \geq b_j, j= 1,2,3.....n \quad (\text{Supply})$$

$$X_{ij} \geq 0 (i = 1,2,3.....m, j = 1,2,3.....n)$$

m = sources, n = locations in the objective function, a_i = volume of the i th sources, b_j = request of j th request locations, C_{ij} = cost of material delivery (dispatching cost) between i th origin and j th request locations, X_{ij} = measure of material sent from i th source to j th request locations. The minimum cost technique, Northwest corner method, Vogel's estimation technique and, the modified distribution (MODI) was engaged to obtain a feasible solution. This will be done via QM software.

6. DATA ANALYSIS AND PRESENTATION

The information for this research was a secondary data gathered from the educational institute. The information includes the transportation cost, requests from the branches and supplies from the organization. The information was investigated using minimum cost technique, Northwest corner technique, Vogel's approximation technique and the modified distribution method (MODI) via QM software. An underlying feasible solution cannot be considered optimal, in light of the fact that there may exist another solution. To examine if an answer is the basic feasible solution for a specific issue, an optimality test was engaged. The study utilized optimality test for all the underlying feasible solution gotten from different technique engaged in the study. This was done to determine the optimality for each technique.

The modified distribution (MODI) was utilized to test for optimality. The table 1 underneath shows the standard transportation cost of moving items from the educational institute (supply) to the different request or demand locations (branches). The transportation cost for each cell is in Naira and it is represented in thousand. While, the supply represents the quantity available at the educational institute and the demand represents the request from the client. In transportation problem model it is fundamental to determine state of the model if it is balanced or not.

- i. If total request or demand = total supplies, this implies the model is balanced.
- ii. If total request or demand \neq total supplies, this implies the model is not balanced.

From Table 1, the overall request or demand = 20,000 and the overall supply = 40,000. This is an unequal model. Therefore, there is a need to balance the model by introducing a dummy request or demand. The dummy request or demand was obtained by subtracting the total request or demand from the total supply i.e. $40000 - 20000 = 20000$ from table 1. Table 2 beneath shows the balanced transportation problem model therefore the initial basic feasible solution was obtained.

Table 1: Information sourced from the educational institute

Demand \ Supplies	Idumota	Iyana Ipaja	Ikeja	Agege	Supply
Ilupeju	20	17	8	15	10000
Isolo/Mushin	15	8	20	8	20000
Asawani	27	15	8	20	10000
Demand	10000	2500	6375	1125	

Table 2: Balanced transportation tableau

Demand \ Supplies	Idumota	Iyana Ipaja	Ikeja	Agege	Dummy	Supply
Ilupeju	20	17	8	15	0	10000
Isolo/Mushin	15	8	20	8	0	20000
Asawani	27	15	8	20	0	10000
Demand	10000	2500	6375	1125	20000	40000

Table 3: Minimum cost technique underlying feasible solution

	Idumota	Iyana Ipaja	Ikeja	Agege	Dummy
Ilupeju	(5)	(9)	(12)	(7)	(0) 10000
Isolo/Mushin	(15) 6375	(8) 2500	(24)	(8) 1125	(0) 10000
Asawani	(27) 3625	(-5)	(8) 6375	(0)	(-12)

$$\text{Min } Z = 15 \cdot 6375 + 8 \cdot 2500 + 1125 \cdot 8 + 3625 \cdot 27 + 6375 \cdot 8 + 10000 \cdot 0 + 10000 \cdot 0 = 273500.$$

Table 4: Testing for optimality using modified distribution (MODI)

	Idumota	Iyana Ipaja	Ikeja	Agege	Dummy
Ilupeju	(5)	(9)	(0)	(7)	(0) 10000
Isolo/Mushin	(15) 10000	(8) 2500	(12)	(8) 1125	(0) 6375
Asawani	(12)	(7)	(8) 6375	(12)	(0) 3625

$$\text{Min } Z = 10000 \cdot 15 + 2500 \cdot 8 + 6375 \cdot 8 + 1125 \cdot 8 + 10000 \cdot 0 + 6375 \cdot 0 = 23000$$

Table 5: Northwest corner technique iteration 1

	Idumota	Iyana Ipaja	Ikeja	Agege	Dummy
Ilupeju	10000	(4)	(-17)	(2)	(-5)
Isolo/Mushin	(0)	2500	6375	1125	(0) 10000
Asawani	(12)	(7)	(-12)	(12)	(0) 10000

Table 6: Northwest cost technique underlying feasible solution

	Idumota	Iyana Ipaja	Ikeja	Agege	Dummy
Ilupeju	(20) 3625	(4)	(15) 6375	(2)	(-5)
Isolo/Mushin	(15) 6375	(8) 2500	(17)	(8) 1125	(0) 10000
Asawani	(12)	(7)	(5)	(12)	(0) 10000

$$\text{Min } Z = 3625 \cdot 20 + 6375 \cdot 15 + 1125 \cdot 8 + 2500 \cdot 8 + 6375 \cdot 15 + 10000 \cdot 0 + 10000 \cdot 0 = 292750.$$

Table 7: Testing for optimality using modified distribution(MODI)

	Idumota	Iyana Ipaja	Ikeja	Agege	Dummy
Ilupeju	(5)	(9)	(8) 6375	(7)	(0) 3625
Isolo/Mushin	(15) 10000	(8) 2500	(12)	(8) 1125	(0) 6375
Asawani	(12)	(7)	(0)	(12)	(0) 10000

$$\text{Min } Z = 10000 \cdot 15 + 2500 \cdot 8 + 6375 \cdot 8 + 1125 \cdot 8 + 3625 \cdot 0 + 6375 \cdot 0 + 10000 \cdot 0 = 230000.$$

Table 8: Vogel estimation final feasible solution using modified distribution (MODI)

	Idumota	Iyana Ipaja	Ikeja	Agege	Dummy
Ilupeju	(5)	(9)	(0)	(7)	(0) 10000
Isolo/Mushin	(15) 10000	(8) 2500	(12)	(8) 1125	(0) 6375
Asawani	(12)	(7)	(8) 6375	(12)	(0) 3625

$$\text{Min } Z = 10000 \cdot 15 + 2500 \cdot 8 + 1125 \cdot 8 + 6375 \cdot 0 + 6375 \cdot 8 + 3625 \cdot 0 = 230000$$

The underlying feasible solution and final solution utilizing the minimum cost technique, Northwest technique, Vogel's estimation technique and the modified distribution(MODI) respectively are stated below, however transportation cost for each cell is in Naira and it is represented in thousand.

- Minimum cost technique underlying feasible solution is : ₦273500
 $\text{₦}273500 \cdot 1000 = \text{₦}273,500,000.$
- Northwest technique underlying feasible solution is: ₦292750
 $\text{₦}292,750 \cdot 1000 = \text{₦}292,750,000.$
- Vogel's estimation technique underlying feasible solution is: ₦230,000
 $\text{₦}2300,00 \cdot 1000 = \text{₦}230,000,000.$

The above outcome portrays that Vogel estimation technique is the most effective considering the number of iterations. It has the least transportation cost before optimality test and require less cycle time. The Northwest corner, Minimum cost and Vogel estimation technique gave an equivalent output of ₦23,000,000 after utilizing the modified distribution (MODI). This shows, the three techniques can be utilized to decide the solution to a given linear transportation model.

7. CONCLUSION

The technique of Northwest corner, minimum cost and Vogel estimation furnished different outputs. The Northwest corner technique was ₦292,750 000, minimum cost technique was ₦273,500 000 and Vogel estimation was ₦230,000 000 as the cost of transportation. The outcome shows that Vogel estimation technique is more proficient than other techniques. After the application of MODI (the modified distribution) the three techniques produced similar output of ₦230,000,000. This shows that, all the three techniques can be utilized to decide the solution to a given linear transportation model. Table 8 shows that, 10,000 packs of textbooks is allocated from Isolo/mushin to Idumota, 2500 packs of textbooks to Iyana Ipaja, 1125 packs of textbooks to Agege and, 6375 packs of textbooks from Asawani to Ikeja. Based on the model an optimal distribution of educational materials was attained to serve different demand locations from Idumota to Iyana-Ipaja to Agege and Ikeja. The optimization of educational material distribution will help the organization to attain a transportation cost of ₦230,000 000.

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