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EFFICIENT IMPLEMENTATION OF THE TRANSPORTATION ALGORITHM FOR THE DISTRIBUTION OF NIGERIA BOTTLING COMPANY PRODUCTS IN THE SOUTH-SOUTH ZONE

[1]F. E. Bazuaye and A. L. Panya[2]

[1] Department of Mathematics and Statistics,
University of Port Harcourt, Rivers State, Nigeria
Email: febazuaye@yahoo.com

[1]Department of Mathematics,
Delta State College of Education, Warri, Delta State, Nigeria

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ABSTRACT
This paper analyses the transportation problem of the NBC, amongst its distribution pattern of the South-South Zone of Nigeria. The Tora software was used to analyze the data. We solved the transportation planning problems sequentially each by the transportation model for the available data from NBC for the 2012 operation year. As a result, we obtained a complete solution consisting of transportation plans. The study revealed the optimal transportation cost of ₦ 792,580,000 against ₦ 857,960,000 that was used in their current distribution schedule. The proposed model solution has demonstrated improvement in cost optimization as compared to the rule-of-thumb based planning.

Key words: *Transportation, Linear Programming, Feasible Solution.*

INTRODUCTION
The transportation problem is one of the subclasses of linear programming problems for which simple and practical computational procedures have been developed to take advantage of the special structure of the problem with the objective to transport various quantities of a single homogeneous product that are initially stored at various origins, to different destinations in such a way that the total transportation cost is minimum.

Onyenuga et al (2011) reports and discussed the transportation problem of Zan Foods and Beverages. In their work, the three method of finding initial basic feasible solution were examined and find out that the VAM gives the least cost of transportation.
Mondal, Hossain and Uddin (2012) introduce a modified VAM method for solving TPs with mixed constraints in More-For-Less paradoxical situation. They developed computer program for solving such problems by simplex algorithm.

MATHEMATICAL FORMULATION
Let us consider m-plant locations (origins) as $S_1, S_2, \ldots S_m$ and the n-retail depots (destination) as $d_1, d_2, \ldots d_n$ respectively. Let $a_i \geq 0, \; i= 1,2, \ldots .m$, be the amount available at the i^{th} plant S_i . Let the amount

required at the j^{th} depot d_j be $b_j \geq 0, j=1,2,\ldots.n.$ Let the cost of transporting one unit of the product form i^{th} origin to j^{th} destination be C_{ij}, $i= 1,2, \ldots.m,\ j=1,2,\ldots.n.$ If $x_{ij} \geq 0$ be the amount of the product to be transported from i^{th} origin to j^{th} destination, then the problem is to determine X_{ij} so as to

Minimize (total cost)Z $\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_{ij}$

Subject to the constraint

$$\sum_{i=1}^{m} x_{ij} = a_i,\ \ i = 1,2,\ldots,m\ \ (\text{sup} ly\, constra\, \text{int}\ s)$$

$$\sum_{j=1}^{n} x_{ij} = b_j,\ \ j = 1,2,\ldots,n\ \ (demand\, constra\, \text{int}\ s)$$

$$and\ x_{ij} \geq 0, for\ all\ i\ and\ j.$$

Any linear programming problem that fits this special formulation is of the transportation problem type, regardless of its physical context. In fact, there have been numerous applications unrelated to transportation that have been fitted to this special structure. This is one of the reasons why the transportation problem is considered such an important special type of linear programming problem.

Fundamental Theorem in Transportation Problem

a. (Existence of Feasible Solution) A necessary and sufficient condition for the existence of a feasible solution to the transportation problem is

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_i$$

That is the total capacity (or supply) must be equal to total requirement (or demand).

b. (Basic Feasible Solution) The number of basic variables (positive allocations) in any basic feasible solution are $m + n - 1$ (the number of independent constraint equations) satisfying all the rim conditions.

DATA ANALYSIS

In this session, we present the analysis of data collected, by using the methods of obtaining initial basic solution and optimality achieved.

Presentation of Data

Two plants are used to provide ten depots with their requirement for products over a year. The yearly capacities of the plants and the requirements of the depots are given in Table 1 (in thousands of cartoons)

Table 1

Plant Capacities	Benin					Port Harcourt				
	7160					6100				
Depots Requirements	Agbor	Airport Rd Rd	Ahoada	Auchi	Benin Urban	Ekpoma	Eleme	Onitsha	Sapele	Warri
	1460	1300	900	900	1550	350	1100	2230	670	1900

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The transportation cost per unit of supplying each depot from each plant are given in Table 2 (in Naira)

Table 2: Unit cost of transportation of products from Plants to Depots (In Naira)

S/N	Plants / Depots	Benin	Port Harcourt
1.	Agbor	69	110
2.	Airport Road	101	25
3.	Ahoada	110	68
4.	Auchi	75	97
5.	Benin Urban	17	134
6.	Ekpoma	60	141
7.	Eleme	106	66
8.	Onitsha	80	91
9.	Sapele	63	105
10	Warri	85	129

The above cost is presented in a transportation model tableau in Table 3

Table 3: Data presentation in a transportation model

S/N	Plants / Depots	Benin	Port Harcourt	Demand
1.	Agbor	69	110	1460
2.	Airport Road	101	25	1300
3.	Ahoada	110	68	900
4	Auchi	75	97	900
5.	Benin Urban	17	134	1550
6.	Ekpoma	60	141	350
7.	Eleme	106	66	1100
8.	Onitsha	80	91	2230
9.	Sapele	63	105	670
10.	Warri	85	129	1980
	Supply	**7160**	**6100**	**DD= 12440** **SS= 13260**

Table 4: A balanced transportation model from plant to depots

Plant / Depot	**Agbor**	**Airport Road**	**Ahoada**	**Auchi**	**Benin Urban**	**Ekpoma**	**Eleme**	**Onitsha**	**Sapele**	**Warri**	**Dummy**	**Supply**
Benin	69	101	110	75	17	60	106	80	63	85	0	**7160**
Port Harcourt	110	25	68	97	134	141	66	91	105	129	0	**6100**
Demand	**1460**	**1300**	**900**	**900**	**1550**	**350**	**1100**	**2230**	**670**	**1980**	**820**	**13260**

The linear programming problem of the problem is thus given as:

$$Minimize\ Z = 69x_{1A} + 101x_{1B} + 110x_{1C} + 75x_{1D} + 17x_{1E} + 60x_{1F} + 106x_{1G} + 80x_{1H} + 63x_{1I} + 85x_{1J}$$

$$110x_{2A} + 25x_{2B} + 68x_{2C} + 97x_{2D} + 134x_{2E} + 141x_{2F} + 66x_{2G} + 91x_{2H} + 105x_{2I} + 129x_{2J}$$

Subject to $x_{1A} + x_{1B} + x_{1C} + x_{1D} + x_{1E} + x_{1F} + x_{1G} + x_{1H} + x_{1I} + x_{1J} = 7160$

$$x_{2A} + x_{2B} + x_{2C} + x_{2D} + x_{2E} + x_{2F} + x_{2G} + x_{2H} + x_{2I} + x_{2J} = 6100$$

$$69x_{1A} + 110x_{2A} = 1460,$$

$101x_{1B} + 25x_{2B} = 1300,$ $110x_{1C} + 68x_{2C} = 900$, $75x_{1D} + 97x_{2D} = 90,$ $17x_{1E} + 134x_{2E} = 155,$ $60x_{1F} + 141x_{2F} = 350,$ $106x_{1G} + 66x_{2G} = 110,$

$80x_{1H} + 91x_{2H} = 2230,$ $63x_{1I} + 105x_{1I} = 670,$ $85x_{1J} + 129x_{2J} = 1980.$

$$X_{ij} \geq 0, i = 1,2; j = A, B \ldots J$$

DISCUSSION

Each of these plants capacities becomes a source. The total supply is 13,260,000 cartoons and each of these depots becomes the destinations, with total demand of 12,440,000 cartoons. Since total supply exceeds total demand, a fictitious destination must be created, with a demand equal to the 820,000 cartoons excess with zero transportation cost in order to make it a balanced transportation model.

The above balanced transportation problem can be solved manually using any of the methods enumerated in the previous chapter. However, in this work, the

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computer software (TORA) will be used in analyzing the data. The software used the three methods: NWCM, LCM and VAM. From the tableau, it could be observed that the supply of the two plants is 13.26 millions cartoons while what were received for the ten depots were 12.44 million cartoons. Hence a dummy destination (demand) of 820,000 cartoons has to be created to balance the supply. The original data is presented in Table A in the appendix. Applying the transportation algorithm to the data, we obtain an optimal solution to the problem as shown in appendix B and the graphical representation in appendix C.

The result of the North West Corner (NWC) had 6 iterations before the optimal solution was obtained. The first iteration has an objective value cost (total cost) of ₦ 1,075,100,000 second iteration has ₦1,016,390,000, third iteration ₦8,627,900,000, fourth iteration ₦ 860,430,000, fifth iteration ₦ 805,830,000 and the final iteration (total cost) of ₦ 792,580,000 against the ₦ 857,960,000 which was used from their current distribution plan.

The Least Cost Method (LCM) gave an optimal solution at the fourth iteration. It started with an objective value cost of ₦ 866,940,000 and the final (fourth) total cost of ₦ 792,580,000.

The Vogel Approximation Method (VAM) had just one iteration before getting to optimum. It has objective value cost of ₦792,580,000. The total cost of transporting the company's product is ₦792,580,000.

Findings

From the analysis and improvement test, the three methods above gave the final optimal solution of N 792,580,000. This was against the N 857,960,000 that was used from their current distribution schedule.

The company will reduce their total transportation cost to ₦ 792,580,000 when they allocate from Benin plant, 1,460,000 cartoons to Agbor, 900,000 cartoons to Auchi, 1,550,000 to Benin Urban, 350,000 cartoons to Ekpoma, 250,000 cartoons to Onitsha, 670,000 cartoons to Sapele and 1,980,000 cartoons to Warri and from Port Harcourt plant, 1,300,000 cartoons to Airport Road, 900,000 cartoons to Ahoada, 1,100,000 cartoons to Eleme and finally 1,980,000 cartoons to Onitsha.

This study has found an optimal transportation schedule as presented in appendices B through the implementation of the transportation algorithm. This reveals that haphazard distribution of products could be counterproductive. It could also be seen that unplanned distribution of products could be uneconomical because it never consider any factors- profit, loss etc.

REFERENCES

Ahuja, R., T. Magnati., J. Orlin and M. Reddy (1995): Application of Network Optimization. Handbooks of Operations Research and Management Science, 1- 83.

Bernard F and Michael P, (2010): Easy distributions for combinatorial optimization problems with probabilistic constraints, *Operations Research Letter*s, 38, Pages 545-549.

Ho, W. and Ji, P. (1982), A genetic algorithm for the generalized transportation problem, *Journal of Manufacturing Systems*, 1(2), Pages 169-182.

Imam,T., G. Elsharawy, M. Gomah and I. Samy(2009): Solving Transportation Problems Using Object-Oriented Model. IJCSNS Vol.9 No.2 pp 353-361.

Mathirajan, M and B. Meenakshi(2004):Experimental Analysis of some Variants of VAM. *Asia-Pacific Journal of Operational Research*. Vol. 21, No. 4, 447-462.

Mondal, R.N, Hossain, B, Uddin, O(2012): Solving TP with mixed constraints. IJMBS Vol.2 Issues 1, Jan-March 2012. 2231-2463.

Pandian. P and D. Anuradha: A new approach for solving solid TPs. *Applied Mathematical Sciences*, Vol. 4, 2010, No. 72, 3603-3610.

Pandian. P and Natarajan.G. (2010): A new method for finding an optimal solution for transportation problems, International Journal of Math. Sci. and Eng. Appls. , 4 (2010), 59-65.

Ping Ji and Chu, K.F (2002): A dual-matrix approach to the transportation problem. *Asia-Pacific Journal of Operations Research* 19, 35-45.

Rao, K.C. and Mishra, S.L. (2005): Operations research: Alpha Science International Ltd.

Reeb,J.E and Leavengood, S.(2002): Transportation problem: A special case for linear programming, Oregon : Oregon State University Extension Service Publications EM 8779.