



Comparison of Statistical Packages in Solving Transportation Problems

(A Case Study of Kwara State Transportation Corporation Kwara Express, Ilorin)

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Abstract: Most often, Lindo and QAM software are computer packages employed in Solving Transportation problems but the commands for these packages are difficult or not easily modifiable to suit general purpose. In this study we employed Visual Basic programme in Solving Transportation problems, which has the advantage of being modified or edited as the user desires. The application of this method was demonstrated using practical data from Kwara State Transportation Corporation and result compared with Lindo and QAM. We found that Visual Basic has fewer numbers of iteration at the optimal level.

Keywords: Lindo, Qam, Packages Transportation and Visual Basic

I. INTRODUCTION

Transportation is the movement of people and commodities from one place to another. The progress of any recent organization depends on the effective utilization of transportation system. Moreover, moving from one place to another or distribution of goods and services always take place through transportation system. The transportation model depends on individual objectives and taste in terms of cost, safety, speed and comfort ability. A transportation problem (TP) consists of determining how to route products in a situation where there are several supply locations and also several destinations in order that the total cost of transportation is minimized. Transportation problem can be described as a way of distributing finished goods from different sources to numerous destinations at a minimum cost or rate. Suppose there are m warehouses, where commodities are stocked and n markets (Locations) where they are needed and supply available in the warehouses be $S_1, S_2, S_3 \dots S_m$ while the demand at the market be $d_1, d_2, d_3 \dots d_n$. Let the unit cost of shipping from warehouse i to market j be C_{ij} . The transportation problem wants to find an optimal shipping schedule which minimizes the cost of transportation from the warehouse to the markets.

II. LITERATURE

The development of operations research as an integrated body of knowledge began during World War II. The first comprehensive operations research was made in Great Britain and dealt with such military problems as the right depth as which to denote anti-submarine the proper size of merchant ship convoys and the relationship between losses

and number of plans information. Operations research emigrated to the United State in the early 1940^{ss} and was extensively used to solve tactical and strategies military problems. Successful applications by the military during and after the war gave expediency for the use of operations research techniques to study business problems. There is currently some software developed to solve transportation problems. Since 1979, "LINDO System" software has been a favorite of the business and educational communities. LINDO System has dedicated itself to providing powerful innovative optimization tools that are also flexible and easy to use. In 1985, Lindo system and General Optimization Jointly developed the first release of "What's Best". "What's best" specialized in tackling large scale, real world problems. By 1991 a utility company in England was using a customized version of "What's Best" to solve spreadsheet model in excess of 100,000 variables. In 1994, "What's best" became the first spreadsheet capable of solving large scale nonlinear models. In 1993, LINDO added a large scale nonlinear solver. In 1995 LINDO system released its first bundled suite of applications educational licenses for the solver suite at the price students could afford. Another software to solve transportation problem is QAM (Quadrature Amplitude Modulation). It is a modulation scheme which conveys data by changing modulate.[2], used different algorithms for solving initial basic feasible solution and optimal solution in Arcgis software environment using VBA and Archobjects and be concluded that Arcgis user can select any network sources and destination and get transportation solution for initial feasible solution. [1], developed a C++ program on the three method of solving transportation problem both on the initial feasible solution and the optimal solution. He compare his

result with the software in order to determine the best method.

In this study, a VISUAL BASIC program will be written on North West Conner Rule, Least Cost Rule and Vogel Approximation Method to obtain initial feasible solution and use these methods to get the optimal solution using modified method and then compare the result with the existing software, LINDO and QAM, using the data in order to determine the best method of allocation or transportation.

III. LINEAR PROGRAMMING FORMULATION

In order to formulate the transportation problem as a linear programming problem, we define X_{ij} as the number of passenger or quantity shipped from warehouse i to market j , $i = 1,2,\dots,m$ and $j = 1, 2, \dots,n$. The number of decision variables is given by the product of m and n . The supply constraint guarantee that the total amounts shipped from any warehouse does not exceed its capacity. The demand constraints guarantee that the total shipped to market including the non-negative constraints, the total number of constraint is $(m + n)$. The market demands of the warehouse are equal to the total demand at the market [3,6].

$$\sum_{i=1}^m S_i = \sum_{j=1}^n d_j$$

This implies that every available passenger at the warehouse will be flee or shipped to meet the minimum demand at the markets. In this case, all the supply and the demand constraint would become strict equalities and we shall have a standard transportation problem given by

$$\text{Min } Z = \sum \sum C_{ij} X_{ij}$$

		TRANSPORTATION TABLE					
		n n					
		M_1	M_2	M_3	.....	M_n	S_i (supply)
W_1		C_{11}	C_{12}	C_{13}	.....	C_{1n}	S_1
W_2		C_{21}	C_{22}	C_{23}	.....	C_{2n}	S_2
.....
.....
W_m		C_{m1}	C_{m2}	C_{m3}	.....	C_{mn}	S_m
Demand d_j		d_1	d_2	d_3	.....	d_n	$\sum_{i=1}^m S_i = \sum_{j=1}^n d_j$

Where

W_1, W_2, \dots, W_m are warehouses (Sources), M_1, M_2, \dots, M_n are the market (Destinations), C_{ij} is the cost of transportation from source i to location j

The above transportation table is standard transportation problem because supply equals demand. For any non-standard transportation problem were the demand and supply are not equal, it must be converted to a standard transportation problem before it can be solved. This

Subject to

$$\sum_{j=1}^n X_{ij} = S_i \quad i = 1, 2, \dots, m \text{ (supply)}$$

$$\sum_{i=1}^m X_{ij} = d_j \quad j = 1, 2, \dots, n \text{ (demand)}$$

$$X_{ij} \geq 0 \text{ for } i \text{ and } j$$

The above transportation problem can be expanded as follows.

$$\text{Min } Z = C_{11}X_{11} + C_{12}X_{12} + \dots + C_{1n}X_{1n} + C_{21}X_{21} + \dots + C_{2n}X_{2n} + \dots + C_{mi}X_{mi} + \dots + C_{mn}X_{mn}$$

Subject to

$$X_{11} + X_{12} + \dots + X_{1n} = S_1$$

$$X_{21} + X_{22} + \dots + X_{2n} = S_2$$

$$\dots \dots \dots$$

$$X_{m1} + X_{m2} + \dots + X_{mn} = S_m$$

$$X_{11} + X_{21} + \dots + X_{m1} = d_1$$

$$X_{12} + X_{22} + \dots + X_{m2} = d_2$$

$$\dots \dots \dots$$

$$X_{1n} + X_{2n} + \dots + X_{mn} = d_n$$

$$S_i \geq 0, d_j \geq 0 \quad \text{for } i = 1,2, \dots, m, \quad j = 1,2, \dots, n$$

The Transportation Array

The transportation problem can be expressed in the form of a table and the value of S_i, d_j and C_{ij} of all the data coefficients associated with the problems are displayed in the table below.

conversion can be done by the use of dummy warehouses or dummy markets as the case may be.

Assumption of Transportation Problem

We have some assumption that will lead us in solving transportation problem.

- 1.All goods must be homogenous, so that origin is capable of supplying to any destination.
- 2.The transportation costs are direct functions of the quantity transported over any route.
- 3.The total quantity available for transportation is equal to the total quantity demanded.

IV. METHOD OF FINDING INITIAL FEASIBLE SOLUTION IN TRANSPORTATION PROBLEM

1. North West Corner Rule Method.
2. Least Cost Rule Method.
3. Vogel Approximation Method.

Non Standard Transportation Problem

For any non-standard transportation problem where the demands and supplies do not balance, this must be converted to a standard transportation problem before it can be solved. This conversion can be achieved by the use of a dummy warehouse or a dummy market.

V. METHOD FOR ESTIMATING OPTIMAL SOLUTION

After an Initial Feasible Solution to the distribution problem has been obtained through North West Corner Rule, Least Cost Rule and Vogel Approximation Method, alternative solution must be evaluated. There are two methods for obtaining the optimal solution, the modified distribution method and the stepping stone method.

In this study a program written will be used to find the initial feasible solution and optimal solution using modified distribution method.

VI. PACKAGES FOR SOLVING TRANSPORTATION PROBLEM

1. LINDO
2. QAM

Description of Data Set

The data used in this research work are secondary data. Data were also collected from records of the Kwara State Transport Corporation, relating to passenger traffic, bus fleet and types, fare charged and organizational structure to assess the operations of the Corporation. The data consist of two sources and seven destinations with average per two weeks demands and supplies and the cost of transportation (₦) per person from each source to each destination.

The Corporation provided two types of service. These are intrastate and interstate services. The intrastate service provides for transportation of passengers between Ilorin and different parts of the state, while interstate service or) the other hand, provides services between Kwara State and other states in the federation. The intrastate service plies between Ilorin and different towns in Kwara State. African Economic and Business Review Vol. 8 No. 1, Spring 2010. ISSN 1109-5609 © 2010 The African Education and Business Research Institute, Inc. 28 namely; Bacita (92 km); Leshu Baruba (136 km); Lafiagi (112 km); Patigi (150 km);

Offa (56 km), Oke-Ode (90 km), Oro Ago (110 km) and Okuta (148 km). The interstate service covers routes between Ilorin and the following: Towns in the country: Abuja (510 km); Zaria (520 km); Jos (781 km); Kano (850 km); Lagos (310 km); Lokoja (331 km); Minna (340 km); Owerri (620 km); Akure (240km), Onitsha (520 km); Makurdi (651 km); Enugu (498 km); Bauchi (913 km) and Owo(282 km). The type of vehicles been used were selected as the sources such as BUSES and CARS. The destinations are the route they plied

Description of Program Written

Visual Basic is the programming language used to write a programming for solving transportation problem using North West, Least Cost and Vogel Approximation Method procedures for solving initial feasible solution and Modified distribution procedure for finding the optimal solution. Visual Basic is one of computer programming languages which is a High Level Language (HLL). It is an Object Oriented Programming (OOP) Language. It is also a scientifically oriented and it is used in handling mathematical problems. Some of the characteristics that make Visual Basic different from other common languages are [4,5,6,7].

1. It has graphical user interface.
2. It is more efficient than other High Level Language (HLL)
3. It is more portable and convectional in nature
4. It has more concise source code
5. It isolates its machine dependent feature to its library formation
6. It user friendly.

VII. CRITERIAL FOR SELECTING THE BEST METHOD

Any method that quickly converges to optimal solution and which gives the lowest numbers of iteration is chosen as the best method. Any package that is able to display the initial feasible solution and optimal solution is also chosen as the best package to be used in solving transportation problem.

VIII. PRESENTATION OF DATA

The data collected from Kwara Express Plc Ilorin were used in this study and it is a secondary data.

The type of vehicles been used were selected as the sources such as BUSES and CARS. The destinations are the route they plied .The sources and their capacities are given in table 1

Table 1:- Shows the sources and supply capacity of Kwara Express Plc. Ilorin

Sources	Supply capacity
BUSES	315
CARS	15
Total	330

Table 2:- Shows the destinations and their requirement of Kwara Express PLC Ilorin.

ZARIA	17
ONITSHA	29
LOKOJA	26
OKUTA	27
TOTAL	337

Destinations	Demand
ABUJA	25
OFFA	173
LAGOS	40

Table 3 Shows the unit cost of transportation in Naira (₦) from sources to destinations.

Sources	ABUJA	OFFA	LAGOS	ZARIA	ONITSHA	LOKOJA	OKUTA
BUSES	3000	250	1500	3500	3000	1500	900
CARS	3500	0	1700	4000	3500	2000	0

BUSES = Warehouse 1 = W_1 ZARIA = Market 4 = M_4
 CARS = Warehouse 2 = W_2 ONITSHA = Market 5 = M_5
 ABUJA = Market 1 = M_1 LOKOJA = Market 6 = M_6
 OFFA = Market 2 = M_2 OKUTA = Market 7 = M_7
 LAGOS = Market 3 = M_3

Table 4 Shows the combined cost matrix, supply capacity and demand

	M_1	M_2	M_3	M_4	M_5	M_6	M_7	S_i
W_1	3000	250	1500	3500	3000	1500	900	315
W_2	3500	0	1700	4000	3500	2000	0	15
d_j	25	173	40	17	29	26	27	330/337

The transportation table above is a Non –Standard transportation problem. To make it a Standard transportation

table, Dummy variable must be introduced to the supply in order to make it balance.

Table 5 Shows the Standard combine cost matrix, supply capacity and demand

	M_1	M_2	M_3	M_4	M_5	M_6	M_7	S_i
W_1	3000	250	1500	3500	3000	1500	900	315
W_2	3500	0	1700	4000	3500	2000	0	15
W_{dummy}	0	0	0	0	0	0	0	07
d_j	25	173	40	17	29	26	27	337

IX. DATA ANALYSIS

The result of initial feasible solution when North West Corner Rule was used is
 $X_{11}=25, X_{12}=173, X_{13}=40, X_{14}=17, X_{15}=29, X_{16}=26, X_{17}=5, X_{26}=15, X_{31}=5, X_{37}=2$ and **Total Cost = ₦363,300**

When Modified distribution was used on Initial Feasible Solution of North West Corner Rule, the optimum result was obtained at 3rd Iteration, with

$X_{11}=25, X_{12}=173, X_{13}=40, X_{14}=10, X_{15}=29, X_{16}=26, X_{17}=12, X_{27}=15$ and **Total Cost = ₦350,050**

The result of initial feasible solution when Least Cost Rule was used is
 $X_{11}=18, X_{12}=158, X_{13}=40, X_{14}=17, X_{15}=29, X_{16}=26, X_{17}=27, X_{22}=15, X_{31}=7$ and **Total Cost = ₦363,300**

When Modified distribution was used on Initial Feasible Solution of Least Cost Rule, the optimum result was obtained at 3rd Iteration, with $X_{11}=25, X_{12}=173, X_{13}=40, X_{14}=10, X_{15}=29, X_{16}=26, X_{17}=12, X_{27}=15, X_{34}=7$ and Total Cost = ₦350,050

The result of initial feasible solution when Vogel Approximation was used is $X_{11}=25, X_{12}=173, X_{13}=40, X_{14}=10, X_{15}=29, X_{16}=26, X_{17}=12, X_{27}=15, X_{34}=7$ and Total Cost = ₦350,050

When Modified distribution was used on Initial Feasible Solution of Vogel Approximation, the optimum result was obtained at 1st Iteration, with $X_{11}=25, X_{12}=173, X_{13}=40, X_{14}=10, X_{15}=29, X_{16}=26, X_{17}=12, X_{27}=15, X_{34}=7$ and Total Cost = ₦350,050

Analysis of Data Using Software

Table 6:- Show the result of LINDO Software on the data.

Variable	Value	Reduced Cost
X ₁₁	25	0
X ₁₂	173	0
X ₁₃	40	0
X ₁₄	10	0
X ₁₅	29	0
X ₁₆	26	0
X ₁₇	12	0
X ₂₁	0	1400
X ₂₂	0	650
X ₂₃	0	1100
X ₂₄	0	1400
X ₂₅	0	1400
X ₂₆	0	1400
X ₂₇	15	0
X ₃₁	0	500
X ₃₂	0	3250
X ₃₃	0	2000
X ₃₄	7	0
X ₃₅	0	500
X ₃₆	0	2000
X ₃₇	0	2000

Number of iteration = 7 and Total Cost = ₦350,050

Table 7:-Shows the result of QAM Software on the data

Origin	Destination	Quantity	Unity Cost/Profit	Total Cost
Origin 1	Destination 1	25	3000	75,000
Origin 1	Destination 2	173	250	43,250
Origin 1	Destination 3	40	1500	60,000
Origin 1	Destination 4	10	3500	35,000
Origin 1	Destination 5	29	3000	87,000
Origin 1	Destination 6	26	1500	39,000
Origin 1	Destination 7	12	900	10,800
Origin 2	Destination 7	15	0	0
Dummy	Destination 4	7	0	0
Total Cost				₦350,050

No of Iteration = 2

From the analysis of the data, the Visual Basic program written on North West Corner Rule is optimal at the third

iteration, Least Cost Rule at the third iteration while Vogel Approximation method is optimal at the first iteration. This indicate that Vogel Approximation Method is the best. Also when QAM and LINDO software were used to analyse the data, QAM gave optimal solution at second iteration while LINDO gave optimal solution at seventh iteration which implied that QAM is the best software for the data.

X. SUMMARY OF FINDING

Summary of the results carried out are presented in the table below

Table 8 Show the results on Data Analysis

	Methods (Programming)	Initial Feasible Solution	Optimal Solution	No of Iteration
1.	North West Corner Rule	₦363,300	₦350,050	3
2.	Least Cost Rule	₦363,300	₦350,050	3
3.	Vogel Approximation Software	₦350,050	₦350,050	1
1.	LINDO	No initial feasible solution	₦350,050	7
2.	QAM	No initial feasible solution	₦350,050	2

From the **table 8** above, we can see that the programming written in this study on Vogel Approximation Method have the least number of iteration both on initial feasible solution and optimal solution. The Softwares provided the same result at optimal solution, with different number of iteration but the programming have the advantages of obtaining initial feasible solution before getting the optimal solution which the Softwares do not have. Hence the programming written on Vogel Approximation Method is the best method.

XI. CONCLUSION

Since program written on Vogel Approximation has the advantages of obtaining initial feasible solution; easy to compute and easy to edit when error are committed in the process of data entering which is not possible when using Softwares. Hence programming written on Vogel Approximation Method using VISUAL BASIC is the best method of getting approximate solution to transportation problem. And the best package for solving transportation problem is VISUAL BASIC program because it able to display initial feasible solution and optimal solution.Hence we conclude that the result of findings will reduce or minimize the cost of transportation problem in the company and will assist in distribution of passenger.

XII. REFERENCE

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