

Modified Passengers Transportation Model in Nigeria, Using Prohibited Routes

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Abstract: *One important use of linear programming is in the area of physical distribution of goods materials and resources, from one place to another to meet a particular target or demand. The transportation algorithm which is movement of goods from one point to another destination is applied to minimize the total cost of passengers' transportation from one place to another within the country Nigeria. Here, there are situations where it is not possible to use certain routes in a transportation problem due to certain operational problems. Therefore, passenger's transportation problem using prohibited route approach of thirty three reputable transits companies in Port Harcourt was modelled. These companies have routes all over the six geopolitical zones in Nigeria; Entraco, Akwa Ibom Transport Company Limited (AKTC), Young Shall Grow Transport Limited (YSG), Agofure, ABC Transport PLC (ABC), Peace Mass Transit (PMT) and Chisco Transportation Limited (C.T) and many more. The data on the amount each of the companies charge per person to a particular destination and the number of persons transported per day were collected from the above mentioned companies, and analysed using TORA 2013. The result outputs were shown in the appendix indicating which transport company passengers should use when travelling to different location at cheaper rate.*

Keyword: *Linear programming, Passengers, Prohibited route, Transportation, Modelling, Minimization*

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I. Introduction

Any time there exist movement of goods from one place to another by several routes, the need to minimize the cost of transportation so as to increase profit on sales also arises. Circumstances could also lead marketing managers or sales managers in an organization to checkmate the total number of goods that are transported from a particular source to different destinations where they are needed at a given period of time.

However, the general transportation problem deals with finding the optimal strategy for carrying a particular commodity from a group of supply point to different destinations, in order to reduce total distribution costs. These commodities include but not restricted to goods and services, passengers.

Thus, Passengers transportation problem implies obtaining the optimum strategy for conveying people from different transport companies to different destinations such that total transportation is minimized.

Several works has been done on transportation since its introduction by Hitchcock in 1941. Recently, Orumie in 2017 modelled, analysed and solved the transportation problem of five known transportation companies that travels or has at least one route across the six geopolitical zones in Nigeria; Akwa Ibom Transport Company Limited (AKTC), Young Shall Grow Transport Limited (YSG), ABC Transport PLC (ABC), Peace Mass Transit (PMT) and Chisco Transportation Limited (C.T).

Her model denied many transport companies the opportunity of been included in the model due to the fact that they don't have routes in all the geopolitical zones, but possibly have minimum cost. This lead to biased result since some of those companies not considered actually charges lesser.

Sometimes, there may be situations where it is not possible to use certain routes in a transportation problem due to certain operational problems such as road construction, bad road conditions, strike, unexpected floods, local traffic rules, terrorist attack etc.. Such constraints can be handled in the transportation problem by assigning a very high cost say M or [infinity] to such routes to ensure that routes will not be included in the optimal solution and then the problem is solved in the usual manner. This is called prohibited transportation routes.

Therefore, the research decided to give other transport companies that were not considered equal opportunity of been included in the model by applying passenger's transportation problem using prohibited route approach. This includes movement of passengers using thirty seven major land transport companies in Port Harcourt that covers at least one city amongst the thirty four major cities across the six geopolitical zones in Nigeria. The objective is such that total amount spent on transportation in Nigeria is minimized by determining the best transport company to use when travelling.

Section two presents the scope of this research work. Section three covers the names of the transportation companies and the cities considered. The methodology, data collection, analyses and interpretation of results are presented in section four, five, six, and seven respectively. Summary, conclusions and recommendations are presented in section eight, nine, and ten and respectively.

II. Scope And Delimitation Of Study

This work is on modelling and solving the transportation problem using prohibited route approach in thirty seven well known transportation companies that have routes in thirty four major cities as shown in section three and four below.

III. Names Of Companies And Cities Considered

The transport companies considered are

Agofure, Famus Big, Famus small, Cross country, RTC big, RTC, ABC, Gog Is Good, Ifeanyichukwu, Genaru, Ago Win, Sonny, Bob Izua, Holy Ghost, Favour, Delking, GUO, ETC, Dominion, Aroji Big, Aroji small, Calculux, ITC, Ameosa, Amazing, Rahony, TEILE, Eddy Son, PMT, Eagle Line, AKTC small, AKTC big, Muiyi, and Ekeson

The cities are;

Lagos, Abuja, Kaduna, Jos, Onitsha, Bayelsa, Uyo, Calabar, Abiokuta, Owerri, Oka, Warri, Delta, Ebonyi, Okigwe, Enugu, Ibadan, Okigwe, sokoto, Gampra, Lokoja, Bauchi, Benin, Auchi, Nsukka, Edo, Uturu, Afikpo, Ugep, and Ogoja

IV. Methodology

The mathematical model of the transportation problem is detailed below;

Let x_{ij} be the number of persons transported from transport company i to City j ($i = 1, 2, \dots, m; j = 1, 2, \dots, n$)

S_i be the supply from company i

d_j , demand at city j ;

c_{ij} is cost per unit distributed from company i to city j .

Therefore, the transportation cost table of the problem is represented thus

Table 4.1 Transportation cost and requirements table

	Cities				Supply
	1	2	...	n	
1	C_{11}	C_{12}	...	C_{1n}	S_1
2	C_{21}	C_{22}	...	C_{2n}	S_2
...
m	C_{m1}	C_{m2}	...	C_{mn}	S_m
Demand	d_1	d_2	...	d_n	

From the table above, the objective becomes to

$$\left. \begin{aligned}
 & \text{Minimize } Z = \sum_{i=1}^m \sum_{j=1}^n c_{ij} x_{ij} \\
 & \text{s.t} \\
 & \sum_{i=1}^m x_{ij} = s_i, \quad j = 1, 2, 3 \dots n \\
 & \sum_{j=1}^n x_{ij} = d_i, \quad i = 1, 2, 3 \dots m \\
 & \sum_{j=1}^n d_j = \sum_{i=1}^m s_i
 \end{aligned} \right\} \dots \dots \dots (4.1)$$

Let ;

c_{11} is the cost of transporting one person from Agofure transport company to ABUJA.

c_{12} is the cost of transporting one person from Agofure transport company to LAGOS.

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$c_{1,34}$ is the cost of transporting one person from Agofure transport company to NSUKKA

c_{21} is cost of transporting one person from FAMUS BIG transport company to ABUJA.

C_{22} is cost of transporting one person from FAMUS BIG transport company to LAGOS .

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$C_{2,34}$ is the cost of transporting one person from FAMUS BIG transport company to NSUKKA

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$C_{37,1}$ is the cost of transporting one person from CROSS COUNTRY transport company to ABUJA.

$C_{37,2}$ is the cost of transporting one person from CROSS COUNTRY transport company to LAGOS.

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$c_{37,34}$ is the cost of transporting one person from CROSS COUNTRY transport company to NSUKKA.

Then them model becomes;

$$\left. \begin{aligned}
 & \text{Minimize } Z = \sum_{i=1}^{37} \sum_{j=1}^{34} c_{ij} x_{ij} \\
 & s.t \\
 & \sum_{i=1}^{37} x_{ij} = s_i, \quad j = 1,2,3...34 \\
 & \sum_{j=1}^{37} x_{ij} = d_i, \quad i = 1,2,3...37 \\
 & \sum_{j=1}^n d_j = \sum_{i=1}^m s_i =
 \end{aligned} \right\} \dots \dots (2.2)$$

The cost table of the above equations are as presented in table 5.1 to table 5.6 of section 5.

The assumption is that the problem must be balanced. i.e., transportation costs of passengers from Transport Company i to city j is directly proportional to the number of passengers transported. $i=1,2...37$, and $j=1,2,...,34$

V. Data Collection

Secondary data were collected from each company. It contains the amount that each company collects per person to different cities for six months, and average taken. The number of buses that loads from different transport line to various routes, together with each bus capacity which makes up the number of persons transported (per month) is collected, and the average per day calculated as shown on the cost matrix below;

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Table 5.1: The cost matrix of the passengers transportation table

TORA File EditGrid

TRANSPORTATION MODEL

Problem Title: PASSENGERS TRANSPORTATION MODEL

No. of Sources: 37

No. of Dest'ns: 34

Editing Grid:
 >>To DELETE, INSERT, COPY, or PASTE a column(row), click heading cell of target column(row), then invoke pull-down EditGrid menu
 >>For INSERT mode, a single(double) click of target row/column will place new row/column after(before) target row/column.

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		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
S/D Name		ABUJA	LAGOS	KADUNA	KANO	JOS	ONITSHA	BAYELSA	UYO	CALABAR	ABEOKUTA	OWERRI	AWKA	WARRI	DELTA	EBONYI
S1	AGUFERE	1500.00	6000.00	34800.00	35600.00	65879.00	1900.00	45999.00	68000.00	2500.00	45000.00	1000.00	2100.00	2000.00	65600.00	54699.00
S2	FAMOUS B	4000.00	4000.00	30000.00	30000.00	40000.00	45000.00	40000.00	56888.00	45888.00	567899.00	550000.00	787777.00	667777.00	878888.00	879999.00
S3	FAMOUS S	7000.00	7000.00	44444.00	44444.00	76899.00	89777.00	67888.00	78999.00	45777.00	45777.00	78999.00	90999.00	76777.00	56666.00	67888.00
S4	RTC B	550007.00	3700.00	55555.00	55555.00	5500.00	1800.00	45333.00	1200.00	2500.00	45555.00	800.00	2000.00	23333.00	22222.00	55666.00
S5	RTC S	7000.00	5000.00	44444.00	55555.00	6000.00	2000.00	45444.00	1950.00	2550.00	66666.00	1000.00	2500.00	34444.00	33333.00	55777.00
S6	ABC	6250.00	6950.00	44444.00	66666.00	56444.00	1950.00	56555.00	56777.00	55555.00	44444.00	666667.00	1350.00	1850.00	44444.00	56777.00
S7	GOD IS GOD	8312.00	666667.00	45555.00	666678.00	56666.00	45666.00	45666.00	44444.00	33333.00	88888.00	33333.00	10000.00	54444.00	55555.00	45666.00
S8	GENARU	8000.00	7000.00	666667.00	66666.00	66777.00	56555.00	56777.00	55555.00	44444.00	666667.00	44444.00	23333.00	34555.00	66666.00	77666.00
S9	EGOWIN	67999.00	4000.00	77777.00	77777.00	56777.00	45333.00	46555.00	66666.00	55555.00	77777.00	55555.00	13333.00	1600.00	77777.00	66777.00
S10	SONNY	77888.00	55666.00	88888.00	88888.00	354455.00	34555.00	1000.00	77777.00	66666.00	66666.00	66666.00	23333.00	1600.00	2000.00	66777.00
S11	BOB IZUAS	99999.00	67888.00	77777.00	78777.00	76777.00	67888.00	43222.00	45555.00	77777.00	55555.00	77777.00	21222.00	2050.00	2050.00	88888.00
S12	BOBIZUAB	88888.00	77666.00	66666.00	99999.00	67666.00	56444.00	34555.00	56666.00	88888.00	44444.00	88888.00	23333.00	3050.00	3050.00	77777.00
S13	HOLYGHO'S	77777.00	56777.00	77777.00	777778.00	45666.00	53666.00	45555.00	56666.00	55555.00	33333.00	99999.00	43444.00	56666.00	88888.00	2000.00
S14	FAMOUSS	88888.00	77888.00	88888.00	88888.00	67777.00	45666.00	56666.00	1200.00	2800.00	66666.00	66666.00	23333.00	77777.00	77777.00	56777.00
S15	FAMOUSB	89777.00	6000.00	99999.00	56666.00	78777.00	34555.00	55555.00	1500.00	2300.00	77777.00	55555.00	12345.00	55555.00	99999.00	45666.00
S16	DELKING	55666.00	4500.00	88888.00	56777.00	56777.00	44444.00	1500.00	1500.00	2300.00	88888.00	66666.00	23444.00	66666.00	66666.00	77777.00
S17	GUO	8000.00	6600.00	66666.00	77777.00	56777.00	45333.00	55555.00	66666.00	55555.00	99999.00	77777.00	34333.00	45333.00	77777.00	78888.00
S18	ETC	56777.00	4100.00	77777.00	66666.00	77777.00	56444.00	66666.00	77777.00	66666.00	88888.00	66666.00	23333.00	66666.00	88888.00	567778.00
S19	DOMINION	89999.00	4500.00	66666.00	55555.00	67666.00	56777.00	77777.00	55555.00	77777.00	77777.00	77777.00	34333.00	1800.00	66666.00	45666.00
S20	AROJS	78999.00	4100.00	66666.00	66666.00	6500.00	1500.00	1200.00	1500.00	2500.00	88888.00	1000.00	12343.00	1800.00	77777.00	1500.00
S21	AROJB	77888.00	55556.00	77777.00	88888.00	56666.00	1300.00	1000.00	1300.00	2300.00	66666.00	800.00	23333.00	1600.00	88888.00	67888.00

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Table 5.2: The cost matrix of the passengers transportation continued

TORA File EditGrid

TRANSPORTATION MODEL

Problem Title: PASSENGERS TRANSPORTATION MODEL

No. of Sources: 37

No. of Dest'ns: 34

Editing Grid:
 >>To DELETE, INSERT, COPY, or PASTE a column(row), click heading cell of target column(row), then invoke pull-down EditGrid menu
 >>For INSERT mode, a single(double) click of target row/column will place new row/column after(before) target row/column.

INPUT GRID - TRANSPORTATION

		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
S17	GUO	8000.00	6600.00	66666.00	77777.00	56777.00	45333.00	55555.00	66666.00	55555.00	99999.00	77777.00	34333.00	45333.00	77777.00	78888.00
S18	ETC	56777.00	4100.00	77777.00	66666.00	77777.00	56444.00	66666.00	77777.00	66666.00	88888.00	66666.00	23333.00	66666.00	88888.00	567778.00
S19	DOMINION	89999.00	4500.00	66666.00	55555.00	67666.00	56777.00	77777.00	55555.00	77777.00	77777.00	77777.00	34333.00	1800.00	66666.00	45666.00
S20	AROJS	78999.00	4100.00	66666.00	66666.00	6500.00	1500.00	1200.00	1500.00	2500.00	88888.00	1000.00	12343.00	1800.00	77777.00	1500.00
S21	AROJB	77888.00	55556.00	77777.00	88888.00	56666.00	1300.00	1000.00	1300.00	2300.00	66666.00	800.00	23333.00	1600.00	88888.00	67888.00
S22	CALCULUX:	5500.00	4500.00	44555.00	56777.00	56777.00	34555.00	45555.00	1500.00	55555.00	77777.00	55555.00	3444.00	45444.00	66666.00	67888.00
S23	CALCULUX:	8000.00	8000.00	55555.00	77777.00	76777.00	66666.00	44444.00	1500.00	44444.00	88888.00	55555.00	45555.00	34444.00	66666.00	56777.00
S24	ITC	11000.00	12000.00	66666.00	77888.00	67778.00	77777.00	55555.00	56666.00	55555.00	99999.00	44444.00	34444.00	23333.00	77777.00	45666.00
S25	AMEOSA	11000.00	12000.00	77777.00	67888.00	67777.00	66666.00	66666.00	55555.00	55555.00	77777.00	55555.00	32222.00	1800.00	88888.00	78777.00
S26	AMAZINS	12000.00	10000.00	55666.00	67888.00	67888.00	55555.00	77777.00	44444.00	66666.00	55555.00	67777.00	23333.00	44444.00	66666.00	78888.00
S27	RAHONNY	5000.00	4000.00	6500.00	67887.00	67777.00	55555.00	77777.00	56666.00	66666.00	44444.00	33333.00	34444.00	55555.00	66666.00	67888.00
S28	TELE	6000.00	5000.00	7000.00	56666.00	67777.00	66666.00	88888.00	56666.00	77777.00	66666.00	33333.00	45555.00	45555.00	66666.00	78888.00
S29	EDDYSON	6000.00	4500.00	67888.00	45666.00	56777.00	77777.00	99999.00	66666.00	55555.00	77777.00	33333.00	45555.00	45555.00	77777.00	78888.00
S30	PHI	7000.00	6000.00	77777.00	45666.00	56777.00	4800.00	45555.00	77777.00	66666.00	88888.00	55555.00	23333.00	45555.00	88888.00	78888.00
S31	EAGLES	5000.00	4000.00	11800.00	66777.00	67777.00	66666.00	55555.00	66666.00	66666.00	99999.00	66666.00	23333.00	1500.00	88888.00	67777.00
S32	EAGLEB	5000.00	5000.00	11700.00	66666.00	56566.00	78777.00	66666.00	56555.00	55555.00	88888.00	77777.00	23333.00	56666.00	99999.00	56778.00
S33	AKTC	55777.00	10000.00	77888.00	88888.00	56778.00	45555.00	55555.00	1500.00	2500.00	77777.00	88888.00	34444.00	67766.00	66666.00	56788.00
S34	MUWB	6000.00	4100.00	77777.00	77777.00	67888.00	56666.00	44444.00	1000.00	1800.00	66666.00	99999.00	23333.00	56444.00	77777.00	88888.00
S35	MUWS	7000.00	6000.00	67888.00	66666.00	56777.00	55555.00	55555.00	1200.00	44444.00	55555.00	99999.00	12333.00	56444.00	77777.00	67777.00
S36	EKESON	6000.00	5000.00	88888.00	77777.00	56777.00	45666.00	66666.00	56666.00	55555.00	66666.00	66666.00	23333.00	45555.00	88888.00	88888.00
S37	GROSS COL	6000.00	5000.00	9000.00	10000.00	67888.00	56777.00	77777.00	44444.00	44444.00	6000.00	77777.00	34555.00	56666.00	55555.00	77777.00
Demand		818	1043	90	43	90	421	96	525	585	45	406	180	483	99	66

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Table 5.3: The cost matrix of the passengers transportation continued

TORA
File EditGrid

TRANSPORTATION MODEL

Problem Title: PASSENGERS TRANSPORTATION MODEL

No. of Sources: 37

No. of Dest'ns: 34

Editing Grid:
 >>> To DELETE, INSERT, COPY or PASTE a column(row), click heading cell of target column(row), then invoke pull-down EditGrid menu
 >>> For INSERT mode, a single(double) click of target row/column will place new row/column after(before) target row/column.

INPUT GRID - TRANSPORTATION

	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30
S1	54699.00	3000.00	2000.00	7000.00	20000.00	30000.00	40000.00	45000.00	44444.00	66666.00	4500.00	3000.00	45555.00	3000.00	66666.00	22222.00
S2	879999.00	34777.00	66777.00	7100.00	34666.00	10000.00	6888.00	9000.00	44444.00	77777.00	4500.00	3100.00	34555.00	3100.00	66666.00	33333.00
S3	67888.00	22222.00	2222.00	22222.00	22222.00	4444.00	6666.00	55555.00	87654.00	77777.00	4444.00	22222.00	6666.00	4000.00	66666.00	44444.00
S4	56666.00	2333.00	1800.00	33333.00	55555.00	8200.00	7500.00	7777.00	6100.00	123456.00	66666.00	5555.00	33333.00	3000.00	4000.00	66666.00
S5	56777.00	2444.00	2000.00	44444.00	33333.00	8500.00	7777.00	6666.00	23456.00	55555.00	6666.00	4444.00	3500.00	5000.00	66666.00	66666.00
S6	56777.00	2555.00	33333.00	55555.00	33333.00	4444.00	8888.00	7777.00	6666.00	7777.00	7777.00	5555.00	6666.00	8000.00	66666.00	77777.00
S7	45666.00	5555.00	44444.00	66666.00	4444.00	5555.00	9999.00	33333.00	33333.00	33333.00	8888.00	6666.00	3372.00	7000.00	66666.00	88888.00
S8	77666.00	6666.00	44444.00	66666.00	6666.00	2222.00	33333.00	33333.00	33333.00	66666.00	5555.00	7777.00	7777.00	9000.00	66666.00	99999.00
S9	66777.00	3000.00	5555.00	8888.00	5555.00	6666.00	2222.00	44444.00	55555.00	4444.00	888999.00	888.00	555.00	66666.00	66666.00	66666.00
S10	66777.00	4444.00	6666.00	9999.00	66666.00	7777.00	44444.00	55555.00	2500.00	44444.00	6666.00	9999.00	999.00	666.00	66666.00	55555.00
S11	88888.00	5566.00	5555.00	44444.00	7777.00	7777.00	66666.00	66666.00	2050.00	2050.00	2050.00	3000.00	999.00	777.00	55555.00	77777.00
S12	7777.00	6666.00	33333.00	7000.00	8888.00	8888.00	7777.00	7777.00	55555.00	3050.00	3050.00	3000.00	888.00	555.00	66666.00	88888.00
S13	2000.00	2500.00	2200.00	33333.00	6666.00	6666.00	77777.00	88888.00	88888.00	33333.00	3900.00	999.00	777.00	43333.00	55555.00	99999.00
S14	56777.00	3000.00	44444.00	22222.00	5555.00	9999.00	55555.00	66666.00	77777.00	44444.00	6666.00	999.00	666.00	45444.00	66666.00	55555.00
S15	45666.00	44444.00	55555.00	44444.00	6666.00	9999.00	33444.00	7777.00	55555.00	44444.00	66666.00	987.00	555.00	3456.00	7777.00	66666.00
S16	7777.00	5555.00	66666.00	55555.00	7777.00	8888.00	99999.00	66666.00	33333.00	33333.00	7777.00	878.00	4444.00	3444.00	8888.00	77777.00
S17	7888.00	6666.00	33333.00	55555.00	8888.00	7777.00	33445.00	9999.00	22222.00	44444.00	77777.00	879.00	3333.00	5555.00	9999.00	88888.00
S18	56777.00	7777.00	44444.00	66666.00	6666.00	5555.00	55666.00	66666.00	33333.00	66666.00	7777.00	7777.00	2222.00	6666.00	7777.00	88888.00
S19	45666.00	5555.00	55555.00	7777.00	5555.00	9999.00	44444.00	44444.00	2500.00	7777.00	88888.00	6666.00	44444.00	7777.00	8888.00	77777.00
S20	1500.00	1800.00	2500.00	33333.00	6666.00	9999.00	33333.00	33333.00	2500.00	66666.00	3500.00	7777.00	44444.00	2000.00	2000.00	2700.00
S21	67888.00	4444.00	66666.00	22222.00	6666.00	4444.00	44444.00	66666.00	1600.00	55555.00	3200.00	44444.00	5555.00	7777.00	88888.00	55555.00
S22	67888.00	3000.00	22222.00	33333.00	7777.00	7777.00	55555.00	88888.00	7777.00	66666.00	44444.00	22222.00	66666.00	8888.00	88888.00	55555.00

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Table 5.4: The cost matrix of the passengers transportation continued

TORA
File EditGrid

TRANSPORTATION MODEL

Problem Title: PASSENGERS TRANSPORTATION MODEL

No. of Sources: 37

No. of Dest'ns: 34

Editing Grid:
 >>> To DELETE, INSERT, COPY or PASTE a column(row), click heading cell of target column(row), then invoke pull-down EditGrid menu
 >>> For INSERT mode, a single(double) click of target row/column will place new row/column after(before) target row/column.

INPUT GRID - TRANSPORTATION

	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30
S17	7888.00	6666.00	33333.00	55555.00	8888.00	7777.00	33445.00	9999.00	22222.00	44444.00	77777.00	879.00	3333.00	5555.00	9999.00	88888.00
S18	56777.00	7777.00	44444.00	66666.00	6666.00	5555.00	55666.00	66666.00	33333.00	66666.00	7777.00	7777.00	2222.00	6666.00	7777.00	88888.00
S19	45666.00	5555.00	55555.00	7777.00	5555.00	9999.00	44444.00	44444.00	2500.00	7777.00	88888.00	6666.00	44444.00	7777.00	88888.00	77777.00
S20	1500.00	1800.00	2500.00	33333.00	6666.00	9999.00	33333.00	33333.00	2500.00	66666.00	3500.00	7777.00	44444.00	2000.00	2000.00	2700.00
S21	67888.00	4444.00	66666.00	22222.00	6666.00	4444.00	44444.00	66666.00	1600.00	55555.00	3200.00	44444.00	5555.00	7777.00	88888.00	55555.00
S22	67888.00	3000.00	22222.00	33333.00	7777.00	7777.00	55555.00	88888.00	7777.00	66666.00	44444.00	22222.00	66666.00	8888.00	88888.00	55555.00
S23	56777.00	4444.00	33333.00	44444.00	8888.00	4444.00	66666.00	66666.00	55555.00	88888.00	3900.00	22222.00	66666.00	6666.00	8888.00	66666.00
S24	45666.00	5555.00	44444.00	55555.00	33333.00	33333.00	77777.00	99999.00	44444.00	99999.00	4444.00	33333.00	7777.00	9999.00	7777.00	66666.00
S25	7877.00	6666.00	55555.00	66666.00	4444.00	22222.00	55555.00	7777.00	2200.00	99999.00	33333.00	55555.00	88888.00	7777.00	6666.00	4444.00
S26	7888.00	6666.00	66666.00	77777.00	5555.00	33333.00	66666.00	55555.00	33333.00	99999.00	44444.00	66666.00	3750.00	8888.00	6666.00	55555.00
S27	67888.00	7777.00	33333.00	55555.00	6666.00	44444.00	66666.00	88888.00	55555.00	88888.00	55555.00	77777.00	88888.00	99999.00	55555.00	88888.00
S28	7888.00	8888.00	22222.00	44444.00	7777.00	55555.00	55555.00	44444.00	66666.00	77777.00	66666.00	88888.00	88888.00	88888.00	7777.00	88888.00
S29	7888.00	8888.00	7777.00	88888.00	8888.00	6666.00	44444.00	44444.00	77777.00	66666.00	77777.00	55555.00	7777.00	77777.00	8888.00	9999.00
S30	7888.00	5555.00	55555.00	5000.00	8888.00	44444.00	55555.00	66666.00	66666.00	77777.00	88888.00	2500.00	66666.00	66666.00	9999.00	7777.00
S31	6777.00	6666.00	44444.00	4000.00	6666.00	5555.00	66666.00	77777.00	55555.00	88888.00	66666.00	3000.00	5555.00	9999.00	8888.00	7777.00
S32	56778.00	6666.00	77777.00	5000.00	6666.00	66666.00	77777.00	66666.00	2500.00	66666.00	6666.00	44444.00	9999.00	8888.00	7777.00	7777.00
S33	56788.00	7777.00	88888.00	66666.00	7777.00	7777.00	55555.00	99999.00	44444.00	55555.00	55555.00	55555.00	9999.00	66666.00	6666.00	66666.00
S34	88988.00	8888.00	44444.00	55555.00	7777.00	99999.00	44444.00	55555.00	2000.00	44444.00	6666.00	22222.00	8888.00	55555.00	7777.00	66666.00
S35	6777.00	6666.00	33333.00	66666.00	6666.00	7777.00	66666.00	88888.00	44444.00	33333.00	44444.00	7555.00	8888.00	44444.00	6666.00	66666.00
S36	8888.00	6666.00	22222.00	7777.00	6666.00	9999.00	77777.00	33333.00	33333.00	3900.00	888.00	5555.00	7777.00	66666.00	555.00	55555.00
S37	7777.00	5555.00	66666.00	6000.00	6666.00	5555.00	5000.00	45555.00	22222.00	22222.00	9999.00	3000.00	7777.00	77777.00	4444.00	55555.00
Demand	66	66	335	92	30	30	30	30	510	54	120	64	146	21	21	21

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Table 5.5: The cost matrix of the passengers transportation continued

TORA
File EditGrid

TRANSPORTATION MODEL

Problem Title: PASSENGERS TRANSPORTATION MODEL

No. of Sources: 37

No. of Dest'ns: 34

Editing Grid:
 >>> To DELETE, INSERT, COPY or PASTE a column(row), click heading cell of target column(row), then invoke pull-down EditGrid menu
 >>> For INSERT mode, a single(double) click of target row/column will place new row/column after(before) target row/column.

INPUT GRID - TRANSPORTATION

	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	Supply
S1	30000.00	40000.00	45000.00	44444.00	66666.00	45000.00	3000.00	45555.00	3000.00	66666.00	22222.00	22222.00	5000.00	3000.00	40000.00	415
S2	100000.00	68888.00	9000.00	44444.00	77777.00	45000.00	3100.00	34555.00	3100.00	66666.00	33333.00	33333.00	5900.00	3100.00	54444.00	70
S3	44444.00	66666.00	55555.00	87654.00	77777.00	4444.00	22222.00	66666.00	4000.00	66666.00	44444.00	44444.00	6000.00	2900.00	33333.00	42
S4	7500.00	77777.00	6100.00	1234567.00	66666.00	5555.00	33333.00	3000.00	4000.00	66666.00	55555.00	55555.00	7000.00	4000.00	44444.00	415
S5	8500.00	77777.00	66666.00	234567.00	55555.00	66666.00	4444.00	3000.00	5000.00	66666.00	66666.00	55555.00	8000.00	55555.00	55555.00	350
S6	44444.00	88888.00	77777.00	66666.00	77777.00	7777.00	5555.00	66666.00	8000.00	66666.00	77777.00	66666.00	9000.00	44444.00	44444.00	365
S7	55555.00	99999.00	33333.00	33333.00	33333.00	88888.00	66666.00	3372.00	7000.00	66666.00	88888.00	77777.00	8976.00	66666.00	55555.00	140
S8	66666.00	22222.00	33333.00	33333.00	66666.00	5555.00	7777.00	7777.00	9000.00	66666.00	99999.00	88888.00	44444.00	66666.00	66666.00	60
S9	66666.00	33333.00	22222.00	44444.00	55555.00	4444.00	8889999.00	8888.00	5555.00	66666.00	66666.00	99999.00	55555.00	7777.00	7777.00	75
S10	7777.00	44444.00	55555.00	2500.00	44444.00	66666.00	99999.00	9999.00	6666.00	66666.00	55555.00	33333.00	66666.00	44444.00	88888.00	135
S11	7777.00	66666.00	66666.00	2050.00	2050.00	2050.00	3000.00	9999.00	7777.00	55555.00	77777.00	55555.00	7777.00	55555.00	7777.00	120
S12	88888.00	77777.00	77777.00	55555.00	3050.00	3050.00	3000.00	8888.00	55555.00	66666.00	88888.00	66666.00	88888.00	33333.00	55555.00	150
S13	66666.00	77777.00	88888.00	88888.00	33333.00	3900.00	9999.00	7777.00	43333.00	55555.00	99999.00	99999.00	44444.00	5555.00	66666.00	135
S14	99999.00	55555.00	66666.00	77777.00	44444.00	66666.00	9999.00	6666.00	45444.00	66666.00	55555.00	99999.00	55555.00	6666.00	78888.00	42
S15	99999.00	333444.00	77777.00	55555.00	44444.00	66666.00	9876.00	5555.00	34567.00	77777.00	66666.00	88888.00	66666.00	7777.00	7777.00	90
S16	88888.00	99999.00	66666.00	33333.00	33333.00	77777.00	8789.00	4444.00	3444.00	8888.00	77777.00	987654.00	7777.00	8888.00	8888.00	90
S17	7777.00	334445.00	99999.00	22222.00	44444.00	77777.00	8798.00	3333.00	5555.00	99999.00	88888.00	765432.00	6666.00	9999.00	99999.00	84
S18	55555.00	555666.00	66666.00	33333.00	66666.00	77777.00	7777.00	22222.00	66666.00	77777.00	66666.00	567890.00	4444.00	6666.00	99999.00	60
S19	99999.00	44444.00	44444.00	2500.00	77777.00	88888.00	66666.00	44444.00	7777.00	88888.00	77777.00	456789.00	8888.00	66666.00	66666.00	105
S20	99999.00	33333.00	33333.00	2500.00	66666.00	3500.00	7777.00	44444.00	2000.00	2000.00	2700.00	4000.00	3800.00	5555.00	77777.00	336
S21	44444.00	44444.00	66666.00	1600.00	55555.00	3200.00	44444.00	55555.00	7777.00	88888.00	55555.00	33333.00	66666.00	44444.00	88888.00	450
S22	7777.00	55555.00	88888.00	77777.00	66666.00	44444.00	22222.00	66666.00	88888.00	88888.00	55555.00	44444.00	7777.00	33333.00	55555.00	360

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Table 5.6: The cost matrix of the passengers transportation continued

TORA
File EditGrid

TRANSPORTATION MODEL

Problem Title: PASSENGERS TRANSPORTATION MODEL

No. of Sources: 37

No. of Dest'ns: 34

Editing Grid:
 >>> To DELETE, INSERT, COPY or PASTE a column(row), click heading cell of target column(row), then invoke pull-down EditGrid menu
 >>> For INSERT mode, a single(double) click of target row/column will place new row/column after(before) target row/column.

INPUT GRID - TRANSPORTATION

	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	Supply
S17	7777.00	334445.00	99999.00	22222.00	44444.00	77777.00	8798.00	3333.00	5555.00	99999.00	88888.00	765432.00	6666.00	9999.00	99999.00	84
S18	55555.00	555666.00	66666.00	33333.00	66666.00	77777.00	7777.00	22222.00	66666.00	77777.00	66666.00	567890.00	4444.00	6666.00	99999.00	60
S19	99999.00	44444.00	44444.00	2500.00	77777.00	88888.00	66666.00	44444.00	7777.00	88888.00	77777.00	456789.00	8888.00	66666.00	66666.00	105
S20	99999.00	33333.00	33333.00	2500.00	66666.00	3500.00	7777.00	44444.00	2000.00	2000.00	2700.00	4000.00	3800.00	5555.00	77777.00	336
S21	44444.00	44444.00	66666.00	1600.00	55555.00	3200.00	44444.00	55555.00	7777.00	88888.00	55555.00	33333.00	66666.00	44444.00	88888.00	450
S22	7777.00	55555.00	88888.00	77777.00	66666.00	44444.00	22222.00	66666.00	88888.00	88888.00	55555.00	44444.00	7777.00	33333.00	55555.00	360
S23	44444.00	66666.00	66666.00	55555.00	88888.00	3900.00	22222.00	66666.00	66666.00	88888.00	66666.00	55555.00	88888.00	44444.00	77777.00	216
S24	33333.00	77777.00	99999.00	44444.00	99999.00	4444.00	33333.00	7777.00	99999.00	7777.00	66666.00	66666.00	66666.00	55555.00	77777.00	224
S25	22222.00	55555.00	77777.00	2200.00	99999.00	33333.00	55555.00	88888.00	7777.00	66666.00	44444.00	77777.00	66666.00	55555.00	88888.00	240
S26	33334.00	66666.00	55555.00	33333.00	99999.00	44444.00	66666.00	3750.00	88888.00	66666.00	55555.00	88888.00	99999.00	55555.00	99999.00	29
S27	44444.00	66666.00	88888.00	55555.00	88888.00	55555.00	77777.00	88888.00	99999.00	55555.00	88888.00	77777.00	8888.00	55555.00	55555.00	100
S28	55555.00	55555.00	44444.00	66666.00	77777.00	66666.00	88888.00	88888.00	88888.00	7777.00	88888.00	88888.00	7777.00	55555.00	66666.00	100
S29	66666.00	44444.00	44444.00	77777.00	66666.00	77777.00	55555.00	77777.00	77777.00	88888.00	99999.00	66666.00	7777.00	55555.00	99999.00	70
S30	44444.00	55555.00	66666.00	66666.00	77777.00	88888.00	2500.00	66666.00	66666.00	99999.00	77777.00	99999.00	3500.00	55555.00	2500.00	618
S31	55555.00	66666.00	77777.00	55555.00	88888.00	66666.00	3000.00	55555.00	99999.00	88888.00	77777.00	99999.00	55555.00	77777.00	44444.00	210
S32	66666.00	77777.00	66666.00	2500.00	66666.00	44444.00	99999.00	88888.00	7777.00	7777.00	44444.00	44444.00	66666.00	2000.00	55555.00	75
S33	77777.00	55555.00	99999.00	44444.00	55555.00	55555.00	55555.00	99999.00	66666.00	66666.00	77777.00	55555.00	7777.00	77777.00	3200.00	84
S34	99999.00	44444.00	55555.00	2000.00	44444.00	66666.00	22222.00	55555.00	88888.00	55555.00	7777.00	66666.00	77777.00	88888.00	66666.00	170
S35	7777.00	66666.00	88888.00	44444.00	33333.00	44444.00	7555.00	8888.00	44444.00	66666.00	66666.00	66666.00	88888.00	99999.00	77777.00	170
S36	99999.00	77777.00	33333.00	33333.00	3900.00	8888.00	5555.00	77777.00	66666.00	5555.00	55555.00	567890.00	88888.00	99999.00	55555.00	150
S37	55555.00	5000.00	45555.00	22222.00	22222.00	99999.00	3000.00	77777.00	77777.00	44444.00	55555.00	456789.00	88888.00	99999.00	344566.00	225
Demand		30	30	510	54	120	64	146	21	21	21	21	64	45	80	

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VI. Analysis

TORA 2013 is used to solve the problem in table 5.1-5.6 and the output result is show in table 6.1 to table 6.4 below;

Table 6.1: RESULT OUTPUT OF THE ANALYSIS

TRANSPORTATION MODEL OUTPUT SUMMARY

Title: passengers transportation model in NIGERIA
Final Iteration No.: 59
Objective Value (minimum cost) =18609599.00

From	To	Amt Shipped	Obj Coeff	Obj Contr
S1: AGOFURE	D11: OWERRI	139	1000.00	139000.
S1: AGOFURE	D13: WARRI	204	2000.00	408000.
S1: AGOFURE	D17: ENUGU	62	2000.00	124000.
S2: FAMOUS BIG	D1: ABUJA	60	4000.00	240000.
S3: FAMOUS SMALL	D26: ABAKILIKI	28	3200.00	89600.
S3: FAMOUS SMALL	D28: UTURU	11	3200.00	35200.
S3: FAMOUS SMALL	D31: OGOJA	3	4800.00	14400.
S4: RTC B	D2: LAGOS	405	3700.00	1488500.
S5: RTC S	D10: ABEOKUTA	45	0.00	0.
S5: RTC S	D17: ENUGU	270	2000.00	540000.
S5: RTC S	D22: BAUCHI	30	7000.00	210000.
S6: ABC	D9: CALABA	180	2550.00	459000.
S6: ABC	D12: OKAH	180	1850.00	333000.
S7: GOD IS GOOD	D4: KANO	22	8312.00	182864.
S7: GOD IS GOOD	D27: EDO	118	3372.00	397896.
S8: GENARU	D29: AFIKPO	21	3000.00	63000.
S8: GENARU	D30: UGEP	21	3499.00	73479.
S8: GENARU	D31: OGOJA	18	5000.00	90000.
S9: EGOWIN	D2: LAGOS	75	4000.00	300000.
S10: SONNY	D7: BAYELSA	96	1000.00	96000.
S10: SONNY	D14: DELTA	39	2000.00	78000.
S11: BOB IZUA S	D14: DELTA	60	2050.00	123000.

Table 6.2: RESULT OUTPUT OF THE ANALYSIS CONTINUED

TRANSPORTATION MODEL OUTPUT SUMMARY

Title: PASSENGERS TRANSPORTATION MODEL
Final Iteration No.: 68
Objective Value (minimum cost) =20064724.00

From	To	Amt Shipped	Obj Coeff	Obj Contr
S11: BOB IZUA S	D25: AUCHI	120	2050.00	246000.
S12: BOBIZUAB	D14: DELTA	85	3050.00	259250.
S12: BOBIZUAB	D24: EKPOMA	54	3050.00	164700.
S12: BOBIZUAB	D25: AUCHI	0	3050.00	0.
S12: BOBIZUAB	D26: ABAKILIKI	11	3000.00	33000.
S13: HOLYGHOST	D17: ENUGU	135	2200.00	297000.
S14: FAMOUSS	D8: UYO	42	1200.00	50400.
S15: FAMOUSB	D9: CALABAR	90	2300.00	207000.
S16: DELKING	D9: CALABAR	90	2300.00	207000.
S17: GUO	D2: LAGOS	84	6600.00	554400.
S18: ETC	D2: LAGOS	60	4100.00	246000.
S19: DOMINION	D13: WARRI	105	1800.00	189000.
S20: AROJS	D11: OWERRI	120	1000.00	120000.
S20: AROJS	D15: EBONYI	66	1500.00	99000.
S20: AROJS	D16: OKIWE	66	1800.00	118800.
S20: AROJS	D28: UTURU	21	2000.00	42000.
S20: AROJS	D29: AFIKPO	21	2000.00	42000.
S20: AROJS	D30: UGEP	21	2700.00	56700.
S20: AROJS	D31: OGOJA	21	4000.00	84000.
S21: AROJB	D11: OWERRI	17	800.00	13600.
S21: AROJB	D23: BENIN	433	1600.00	692800.
S22: CALCULUXB	D1: ABUJA	109	5500.00	599500.
S22: CALCULUXB	D2: LAGOS	154	4500.00	693000.

Table 6.3: RESULT OUTPUT OF THE ANALYSIS CONTINUED

TRANSPORTATION MODEL OUTPUT SUMMARY

Title: PASSENGERS TRANSPORTATION MODEL
Final Iteration No.: 68
Objective Value (minimum cost) =20064724.00

Route	Destination	Passenger Count	Cost	Total Cost
S21: AROJB	D23: BENIN	433	1600.00	692800.00
S22: CALCULUXB	D1: ABUJA	109	5500.00	599500.00
S22: CALCULUXB	D2: LAGOS	154	4500.00	693000.00
S22: CALCULUXB	D8: UYO	97	1500.00	145500.00
S23: CALCULUXS	D8: UYO	216	1500.00	324000.00
S24: ITC	D1: ABUJA	224	11000.00	2464000.00
S25: AMEOISA	D13: WARRI	235	1800.00	423000.00
S25: AMEOISA	D23: BENIN	5	2200.00	11000.00
S26: AMAZING	D27: EDO	29	3750.00	108750.00
S27: RAHONNY	D2: LAGOS	100	4000.00	400000.00
S28: TEILE	D2: LAGOS	10	5000.00	50000.00
S28: TEILE	D3: KADUNA	90	7000.00	630000.00
S29: EDDYSON	D2: LAGOS	70	4500.00	315000.00
S30: PMT	D6: ONITSHA	421	1600.00	673600.00
S30: PMT	D26: ABAKILIKI	53	2500.00	132500.00
S30: PMT	D32: IKOM	64	3500.00	224000.00
S30: PMT	D34: NSUKKA	80	2500.00	200000.00
S31: EAGLES	D13: WARRI	118	1500.00	177000.00
S31: EAGLES	D18: IBADAN	92	4000.00	368000.00
S32: EAGLEB	D23: BENIN	72	2500.00	180000.00
S32: EAGLEB	D33: SAPELE	3	2000.00	6000.00
S33: AKTC	D9: CALABAR	84	2500.00	210000.00
S34: MIUYIB	D9: CALABAR	170	1800.00	306000.00

Table 6.4: RESULT OUTPUT OF THE ANALYSIS CONTINUED

TRANSPORTATION MODEL OUTPUT SUMMARY

Title: PASSENGERS TRANSPORTATION MODEL
Final Iteration No.: 68
Objective Value (minimum cost) =20064724.00

Route	Destination	Passenger Count	Cost	Total Cost
S25: AMEOISA	D13: WARRI	235	1800.00	423000.00
S25: AMEOISA	D23: BENIN	5	2200.00	11000.00
S26: AMAZING	D27: EDO	29	3750.00	108750.00
S27: RAHONNY	D2: LAGOS	100	4000.00	400000.00
S28: TEILE	D2: LAGOS	10	5000.00	50000.00
S28: TEILE	D3: KADUNA	90	7000.00	630000.00
S29: EDDYSON	D2: LAGOS	70	4500.00	315000.00
S30: PMT	D6: ONITSHA	421	1600.00	673600.00
S30: PMT	D26: ABAKILIKI	53	2500.00	132500.00
S30: PMT	D32: IKOM	64	3500.00	224000.00
S30: PMT	D34: NSUKKA	80	2500.00	200000.00
S31: EAGLES	D13: WARRI	118	1500.00	177000.00
S31: EAGLES	D18: IBADAN	92	4000.00	368000.00
S32: EAGLEB	D23: BENIN	72	2500.00	180000.00
S32: EAGLEB	D33: SAPELE	3	2000.00	6000.00
S33: AKTC	D9: CALABAR	84	2500.00	210000.00
S34: MIUYIB	D9: CALABAR	170	1800.00	306000.00
S35: MIUYIS	D8: UYO	170	1200.00	204000.00
S36: EKESON	D2: LAGOS	150	5000.00	750000.00
S37: CROSS COUNTRY	D2: LAGOS	107	5000.00	535000.00
S37: CROSS COUNTRY	D4: KANO	43	10000.00	430000.00
S37: CROSS COUNTRY	D10: ABEOKUTA	45	6000.00	270000.00
S37: CROSS COUNTRY	D21: LOKOJA	30	5000.00	150000.00

VII. Interpretation Of The Result

The cost matrix for the thirty seven transportation company as shown on the tables in section 5 above is analysed using TORA 2003 and the results obtained as shown in table 6.

The result output shows that in order to minimize transportation cost when travelling to Owerri, one can choose to go by either Agofure or Peace Mass Transit at one thousand naira or eight hundred naira respectively.

When travelling to Warri, one can choose to go by Agofure at two thousand naira or Dominion and Ameosa at one thousand eight hundred naira.

When travelling to Enugu, one can choose to go by Agofure or RTC at two thousand naira or by Holy Ghost at two thousand, two hundred naira.

The result output shows that when travelling to Abuja, one can choose to go by Famous at four thousand naira or by Calculux at five thousand, five hundred naira or by Rahony, Eagle at five thousand naira or by Ekeson and Cross Country at six thousand naira.

When travelling to Abakiliki, one can choose to go by Famous at three thousand, two hundred naira or Bob-Izua at three thousand naira.

When travelling to Uturu, one can choose to go by Famous at three thousand, two hundred naira or by Aroji at two thousand naira.

When travelling to Ogoja, one can choose to go by Famous at four thousand, eight hundred naira or by Genaru at five thousand naira.

When travelling to Lagos, one can choose to go by RTC at three thousand, seven hundred naira or by Egowin at four thousand naira or by Delkin at four thousand, five hundred naira or by ETC at four thousand one hundred naira or by Dominionat four thousand, fivehundred naira or by Aroji at four thousand five hundred naira or Eddyson at four thousand, five hundred naira or by Cross Country at five thousand naira.

When travelling to Calabar, one can choose to go by ABC at two thousand, five hundred and fifty naira or by Favours one thousand, eight hundred naira or by GUO at three thousand naira or by FavorB at Two thousand three hundred naira or by Delkin at two thousand, three

When travelling to Okah, one can only travel ABC at one thousand, eight hundred and fifty naira.

When travelling to Kanoone can only travel by God is Good at eight thousand five hundred naira

When travelling to Edo, one can travel by either God is Good or Amazing at three thousand five hundred naira or three thousand seven hundred naira respectively.

When travelling to Afikpo or Ugep, one can only travel by Genaru at three thousandnaira or three thousand, fivehundred naira respectively.

When travelling to Bayelsa, one can only travel by Sonny one thousand naira only.

When travelling to Delta, one can travel by Sonny or Bob- Izua at two thousand and fifty naira

When travelling to Auchi, one can go by Bob- Izua at three thousand and fifty naira

When travelling to Ebonyi and Okigwe, one can only travel by Holy ghost at two thousand naira only and at two thousand, five hundred naira only.

When travelling to Uyo, one can travel by either Calculux or EKTC at one thousand five hundred naira or by Muiy at one thousand two hundred naira.

When travelling to Onitsha, one can travel by either ITC or PMT at one thousand five hundred naira or one thousand six two hundred naira respectively.

When travelling to Ekpoma, one can only travel by Bob-Izuas two thousand and fifty naira.

When travelling to Benin, one can go by either Ameosa or EagleB at two thousand two hundred naira or at two thousand five hundred naira respectively.

When travelling to Nsukka, one can go by PMT only at two thousand five hundred naira .

When travelling to Kadun, one can go by Teile only at seven thousand naira only

When travelling to Ikom, one can go by PMT only at three thousand five hundred naira .

When travelling to Sapele, one can go by EagleB only at two thousand naira

When travelling to Jos, one can go by Ekeson at ten thousand two hundred naira

When travelling to Sokoto and Gampra, one can only go by RTC at eight thousand two hundred naira and eight thousand five hundred naira respectively.

When travelling to Ibadan, one can only go by PMT at four thousand naira only.

When travelling to Lokoja, one can only go by Cross Country at five thousand naira only.

8.0 SUMMARY AND CONCLUSION OF THE RESULT

From section seven above, it is observed that in order to minimize passengers cost of transportation, commuters are advised to adhere strictly to the cost matrix.

Agofure and Peace Mass Transitcompete when going to Owerri.

Agofure, Dominion and Ameosa compete when travelling to Warri,

Agofure , RTC and Holy Ghost compete when travelling to Enugu

Famous, Calculux, Rahony , Eagle, Ekeson and Cross Country compete when travelling to Abuja,

Famous and Bob-Izuacompete when travelling to Abakiliki

Famous and Aroji compete when travelling to Uturu,

Famous and Genaru competes when travelling to Ogoja,

RTC, Egowin, Delkin, ETC, Dominion, Aroji , Eddyson and Cross Country compete when travelling to Lagos

ABC, Favours, GUO , FavorB and Delkin compete when going to Calabar

One can choose to go to Okah, by only ABC

God is Good is the only vehicle to board when travelling to Kano

God is Good and Amazing compete when travelling to Edo
One can only travel by Genaru to Afikpo or Ugep.
One can only travel by Sonny to Bayelsa,
Sonny or Bob- Izua compete when travelling to Delta
One can only go by Bob- Izua to Auchi,
One can only travel by Holy ghost to Ebonyi and Okigwe.
Calculux, EKTC , and Muyi compete when travelling to Uyo
ITC and PMT compete when travelling to Onitsha
One can only travel by Bob-Izuas to Ekpoma,
Ameosa and EagleB compete for Benin.
One can only go by PMT to Nsukka,
One can only travel by Teile to Kadun
One can only go by PMT to Ikom,
One can go by EagleB when travelling to Sapele,
One can go by Ekeson when travelling to Jos,
Only RTC is to go to Sokoto and Gampra
When travelling to Ibadan, one can only go by PMT
When travelling to Lokoja, one can only go by Cross Country

4.2 RECOMMENDATION

In order to ensure that commuters pay less for transportation, the following are recommended based on the cheapest companies' amongst the competitors.

Peace Mass Transit –Owerri, Dominion or Ameosa - Warri, Agofure or RTC – Enugu,
Famous -Abuja,Bob-Izua – Abakiliki, Aroji -Uturu,Famous - Ogoja, RTC- Lagos , Bob-Izua – Abeokuta, RTC-
Bauchi, Favours – Calabar, ABC - Okah, God is Good – Kano and Edo,
Genaru - Afikpo and Ugep, Sonny -Bayelsa,Sonny or Bob- Izua –Delta, Bob- Izua - Auchi,
Holy ghost -Ebonyi and Okigwe, Muyi –Uyo, ITC – Onitsha, Bob-Izuas -Ekpoma, Ameosa – Benin, PMT -
Nsukka,Teile – Kaduna, PMT - Ikom,EagleB -Sapele,Ekeson -to Jos,RTC -Sokoto and Gampra, Cross Country
–Lokoja, and PMT – Ibadan.

Also affected companies should reduce their transport cost in order to compete with other companies to enhance speedy and safe services.

Multiple objective optimization technique such as Goal programming should be used to solve this problem when by incorporating other objective functions such as companies profit maximization, companies' speed limit, and passengers' conduciveness.

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