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 transit 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

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 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, Muyi, and Ekeson.
The cities are:

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 \( j \) (\( i = 1,2,...,m; j = 1,2,...,n \))
\( s_i \) 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>
<thead>
<tr>
<th>Cities</th>
<th>( s_1 )</th>
<th>( s_2 )</th>
<th>...</th>
<th>( s_m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( C_{11} )</td>
<td>( C_{12} )</td>
<td>...</td>
<td>( C_{1n} )</td>
</tr>
<tr>
<td>2</td>
<td>( C_{21} )</td>
<td>( C_{22} )</td>
<td>...</td>
<td>( C_{2n} )</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>m</td>
<td>( C_{m1} )</td>
<td>( C_{m2} )</td>
<td>...</td>
<td>( C_{mn} )</td>
</tr>
<tr>
<td>Demand</td>
<td>( d_1 )</td>
<td>( d_2 )</td>
<td>...</td>
<td>( d_n )</td>
</tr>
</tbody>
</table>

From the table above, the objective becomes to

**Minimize** \( Z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} \)

s.t

\[ \sum_{j=1}^{n} x_{ij} = s_i, \quad j = 1,2,..,n \]  

\[ \sum_{i=1}^{m} x_{ij} = d_j, \quad i = 1,2,..,m \]

\[ \sum_{j=1}^{n} d_j = \sum_{i=1}^{m} s_i \]

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

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

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

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

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

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

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

Then the model becomes:

\[
\begin{align*}
\text{Minimize } Z &= \sum_{i=1}^{37} \sum_{j=1}^{34} c_{ij} x_{ij} \\
\text{s.t. } & \\
\sum_{i=1}^{37} x_{ij} &= s_j, \quad j = 1, 2, 3, \ldots, 34 \\
\sum_{j=1}^{37} x_{ij} &= d_i, \quad i = 1, 2, 3, \ldots, 37 \\
\sum_{j=1}^{m} d_j &= \sum_{i=1}^{n} s_i
\end{align*}
\]

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 month, 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;
Table 5.1: The cost matrix of the passengers transportation table

Table 5.2: The cost matrix of the passengers transportation continued
Table 5.3: The cost matrix of the passengers transportation continued

![Table 5.3: The cost matrix of the passengers transportation continued]

Table 5.4: The cost matrix of the passengers transportation continued

![Table 5.4: The cost matrix of the passengers transportation continued]
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

Table 6.2: RESULT OUTPUT OF THE ANALYSIS CONTINUED
Table 6.3: RESULT OUTPUT OF THE ANALYSIS CONTINUED

Table 6.4: RESULT OUTPUT OF THE ANALYSIS CONTINUED

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 result 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-Izuua 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, five hundred 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 five hundred naira or by Delkin at two thousand, three hundred five hundred naira.
When travelling to Okah, one can only travel ABC at one thousand, eight hundred and fifty naira.
When travelling to Kano, one can only travel by Holy ghost at two thousand naira only and at two thousand, five hundred naira only.
When travelling to Yola, one can travel by either Calculux or EKTC at one thousand five hundred naira or FavorB at Two thousand two hundred naira respectively.
When travelling to Afikpo or Ugep, one can only travel by Genaru at three thousand and four hundred 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- Izuua at two thousand and fifty naira.
When travelling to Auchi, one can go by Bob- Izuua 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 FavorB at two thousand five hundred naira respectively.
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 thousand naira.
When travelling to Jos, one can go by Ekeson at ten thousand two hundred naira.
When travelling to Sokoto and Gampara, 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 Genarute compete 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
Onecan 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,
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 toNsukka.
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 - Warrri, 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.

References
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