MAXIMISING PROFITS FROM PASSENGER TRANSPORT SERVICE USING TRANSPORTATION MODEL ALGORITHM

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ABSTRACT

The diversity and complexity of the different types of passenger transportations in operation today invokes the need for an efficient transport service management system. Existing transportation models tend towards proffering solution for finding the least cost combination for delivering cargoes from various depots to known remote customer destinations. This paper looks at the possibility of adopting and or modifying the existing model for use in the management of passenger transport services. A preliminary investigation using the Nigerian private transport sector management practices situation show that inability to apply scientific based approach to vehicle capacity assignment and passenger volume projection stands in the way of profit maximization for most indigenous transport companies. The paper clearly suggests that adopting the transportation model algorithm for estimating the best vehicle assignment method to routes will optimize operational decisions.

Keywords: Transportation; Passenger; Manifest; Route; Modeling; Volume; Profit.

JEL Classification: R41, C63, M49.

INTRODUCTION

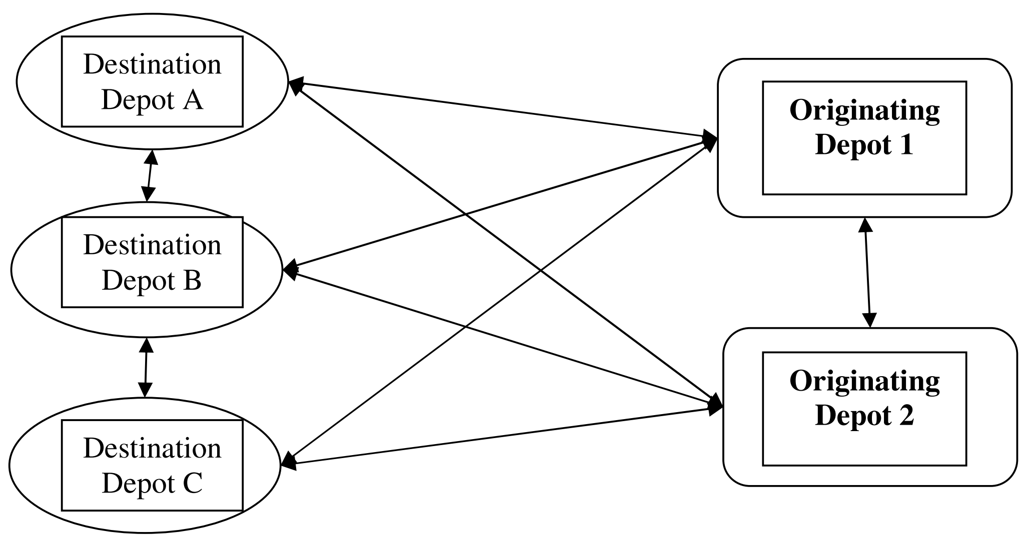
The primary objective of a business entity is to maximize owners equity (VanHorne, 1977; Brockington, 1988). But how does a passenger transport service company maximize profit from its operations? The answer to this question is not far fetched; it is simply by taking advantage of all situations. How? Well, a simple analysis of the profits of 13 listed companies tends to suggest that those companies applying operational research techniques to aid decision making tend to perform better than those that do not apply them. Passenger transport service business in Nigeria is the most competitive, most vulnerable and most volatile of all sectors in the Nigerian economy. The reasons for these are not too difficult to discern. First Nigerians are highly mobile people willing to travel at short notice; secondly, apart from road transportation which is even characterized by lack of effective government coordination, other forms of transport are still highly underdeveloped; thirdly, most transport operators in Nigeria are still "***traditional***" in their approach to doing business due to the virtually low level of intellectual development prevailing amongst them. Furthermore, the transport business brings in very high and quick returns than other forms of business especially during festivity periods.

Within the past two decades, many good and promising transport companies have come and gone with most unable to withstand the pervading competition while others simply mismanaged their successes. One thing stands out though, and that is the deficiency of these transporters in the management of ***peak periods***. This is mostly caused by their inability to apply resourceful and scientific methods such as mathematical algorithms in the assignment and scheduling of passenger vehicles and manpower resources. The objective of this paper is to espouse the need for the use of mathematical models and scientific algorithms in the scheduling and assignment of organizational resources for the purpose of optimizing the use of organizational resources. We shall do this by taking example from a true transport business situation in Nigeria using a modified transportation modeling technique adapted especially for the purpose of this paper, but before this let us look at the historical background of road transport business in Nigeria.

Background of the Nigerian Road Passenger Transport Service

During the colonial days when cars and buses are relatively scarce, the major systems of mass transport of people and cargo are the Nigerian Railway (now in moribund state) and the popular gwon-gworo or mammy wagon. These modes of transportation, though, still very much in existence were complimented with the introduction of the luxury bus system by the then Midwestern state towards the tail end of the 60s. This luxury bus system called ***Mid West Line*** operated from Benin-City to Lagos and from Lagos to Kaduna, Kano and Jos. The ***Mid West Line*** was later joined by such other transport services like ***Oriental line*** from the then East Central State, ***Benue-Plateau Bus Service*** and other state owned transports services which have all gone underground at the moment. A new chapter on the Nigerian road passenger transport service came alive with the introduction of private operators in the late 80s. The likes of ***Ekene Dili Chukwu***, ***Chidi Ebere Transport***, ***PN Emerah***, ***Madugu Na Bakon Waya*** and ***Ifesinachi Transport Services*** revolutionalized this sector with modern fleets and plying of new routes. Some later entrants like ***ABC*** and ***CN Okoli*** added more vigor by plying routes even beyond the shores of Nigeria and offering services comparable to what obtains in developed countries while making full use of passenger manifests at loading points. Curiously, one prominent feature amongst these transport operators is that majority operated their originating depots from the Eastern cities. This is not surprising as most of the proprietors are based in that part of the country. A typical luxury bus transport system network is given in ***Figure 1*** below:

FIGURE 1: **A TYPICAL NIGERIAN ROAD PASSENGER TRANSPORT SYSTEM NETWORK**



A Case Study

A bus company operates from Enugu, Aba, Calabar, Onitsha and Port-Harcourt in the east to Lagos, Ibadan, Ilorin, Kano and Jos. It has a total of 175 serviceable buses in its fleet. The buses were sent out on a typical day during the December peak period to convey eastern bound passengers returning for the Christmas in the following order: Lagos 54 buses, Ibadan 19 buses, Ilorin 26 buses, Kano 57 buses and Jos 19 buses.

The passenger expectations to the five eastern routes are Aba 2000 passengers, Enugu 1900 passengers, Port-Harcourt 2000 passengers, Calabar 1600 passengers and Onitsha 3000 passengers.

The following table holds the number and mix of passengers available at each of the five originating cities:

TABLE 1: PASSENGER AVAILABILITY TABLE

TO	Lagos	Ibadan	Ilorin	Kano	Jos	Total
Aba	600	250	300	700	150	2000
Enugu	725	205	120	450	200	1900
P/H	750	300	180	650	120	2000
Calabar	700	180	100	400	220	1600
Onitsha	930	400	320	850	500	3000
TOTAL	**3,905**	**1335**	**1020**	**3050**	**1,190**	**10,500**

The contribution per passenger (after adjusting for direct costs on full load) on each route is tabulated bellow:

TABLE 2: CONTRIBUTION PER PASSENGER

	Lagos	Ibadan	Ilorin	Kano	Jos
Aba	1932	1932	2078	2325	1679
Enugu	1950	1950	2096	2143	1696
P/H	2214	2214	2361	2607	1961
Calabar	2714	2714	2661	2589	2161
Onitsha	1750	1750	1896	2143	1496

Expectations

With the four vital information as above in hand, all we are expected to do is to:

(a) Find the total value of contribution expected above (the *initial value*);

(b) Apply a mathematical algorithm to rearrange or re-assign the buses in accordance with passenger availability and route profitability;

(c) Find the total value of contribution expected after the reassignment (the *final value*) and compare it with the initial value.

Procedure

First we convert the *number of passenger per route* to the *number of buses per route* by dividing the number of passengers by 60 for each route. Here, 60 is assumed as the maximum number of passengers per bus (full load). See table 3 bellow.

TABLE 3: BUS REQUIREMENTS PER ROUTE

	Lagos	**Ibadan**	**Ilorin**	**Kano**	**Jos**
Aba (33)	10	4	5	12	3
Enugu (32)	15	3	2	8	3
P/H (33)	13	5	3	11	2
Calabar (27)	12	3	2	6	4
Onitsha (50)	16	6	5	14	8
Total (175)	**66**	**21**	**17**	**51**	**20**

(All divisions rounded to the nearest whole number)

Next, we compare the bus requirements with the bus availability at the various depots:

TABLE 4: COMPARISON OF BUS REQUIRED WITH BUS AVAILABLE

	(Total)	Lagos	Ibadan	Ilorin	Kano	Jos
Available	(175)	54	19	26	57	19
Required	(175)	66	21	17	51	20
Surplus/(Shortfall) -		**(12)**	**(2)**	**9**	**6**	**(1)**

As seen from the analysis, Lagos, Ibadan and Jos have shortfalls while Kano and Ilorin have surplus buses. The problem now is how to re-allocate the surplus buses to areas of need with utmost efficiency. Normally, the guiding principle will be the ability to make optimal allocation. We do this by first assessing the present position by calculating the total contribution available from the current assignment as follows:

From Lagos Depot (Available = 54 buses) To:

City	Proportion	(Contribution X 60)	Total Contribution
Aba	(10/66) x 54	115, 920	948, 436
Enugu	(15/66) x 54	117,000	1,435,909
P/H	(13/66) x 54	132,840	1,412,935
Calabar	(12/66) x 54	162,840	1,598,793
Onitsha	(16/66) x 54	105,000	1,374,545
	Total from Lagos		**6,770,618**

We also calculate from Ibadan depot with 19 buses to each of the five eastern destinations using similar calculations as above, as well as for each of the other depots at Ilorin, Kano and Jos. However when computing for routes with excess buses we simply multiply the requirement straight by the contribution without the use of proportions unlike the case of depots with shortfalls. This was done for Ilorin and Kano. After these computations are made, the contributions expected from all routes are given in table 5 as follows:

TABLE 5: INITIAL EXPECTED CONTRIBUTIONS BY DEPOTS

DEPOT	**CONTRIBUTION**
Lagos Depot	6,770,618
Ibadan Depot	2,350,028
Ilorin Depot	2,188,020
Kano Depot	7,155,420
Jos Depot	1,975,563
TOTAL INITIAL EXPECTED CONTRIBUTION =	**20,439,649**

Next, we try to maximize the above contribution by making further comparative analysis and re-assignments on the basis of some shadow contribution computations. To begin with, we set out the table of required and available buses from each of the routes to their various destinations making our initial reassignments on the basis of highest contribution as follows:

TABLE 6: COMPARATIVE BUS STATISTICS TABLE

	Lagos	Ibadan	Ilorin	Kano	Jos	Total
Available	54	19	26	57	19	175
Aba	10:10	4:4	5:5	12:12	3:3	34:34
Enugu	15:15	3:3	2:2	8: 8	3:3	31:31
PHC	13:13	5:5	3:3	11:11	2:2	34:34
Calabar	12:12	3:3	2:2	6: 6	4:4	27:27
Onitsha	16: 4	6:4	5:14	14:20	8:7	49:49
Difference	(12)	(2)	+9	+6	(1)	-

The order of assignment is based on the value of contribution per passenger per route using the data in table 2. The route with the highest contribution is given full allocation first, then followed by the one with the next highest and so on until the residue is left for the route with the least contribution. The two values in the table for each route represent the required number of buses against the available number. The value to the left of the colon is the required number while those to the right are the available ones. The first group of numbers are obtained from table 3 while the second group are reassigned using the method stated above.

To re-allocate vehicles from surplus routes to needy ones, the cost implications must be considered. This is because transferring a vehicle from one route to another will involve costs such as fuel, oil, minor maintenance expenses as well as lost time. . The farther apart the two depots the higher the cost of transfer. For this reason, it will be cheaper to transfer from nearer depots first before considering far away ones. Another aspect to consider in the transfer option is the value of contribution at each of the needy routes. The route with the highest contribution margin per passenger gets priority in the reallocation of buses followed by the one with the next highest, and in that order until the routes or the vehicles being re-allocated are exhausted.

From table 6 above, we can see that the depots requiring buses are Lagos (12), Ibadan (2) and Jos (1) while only three routes (Lagos – Onitsha, Ibadan – Onitsha, and Jos – Onitsha) requires re-assignment of vehicles.

Tabulated bellow are additional costs of re-assigning vehicles from one depot to another.

Table 7: COST OF SENDING A BUS FROM DEPOT TO DEPOT

	LAGOS	**IBADAN**	**ILORIN**	**KANO**	**JOS**
LAGOS	-	5000	8000	20000	18000
IBADAN	5000	-	4000	18000	16000
ILORIN	8000	4000	-	16000	14000
KANO	20000	18000	16000	-	4000
JOS	18000	16000	14000	4000	-

From Table 3, we can see that Lagos and Ibadan depots have the same contribution margin per passenger for all routes, however, Ibadan is nearer to the two surplus depots at Ilorin and Kano; therefore, we satisfy the requirements of Ibadan first preferably from Ilorin depot to reduce costs. Thereafter, Lagos will be satisfied from the residue at Ilorin and from the Kano depot, while Jos shortfall will be remedied from the Kano depot also. Analysis of the cost implication for this reassignment action is tabulated bellow:

TO / FROM	ILORIN	KANO	TOTAL
Ibadan	2 x 4000	-	8,000
Lagos	7 x 8000	5 x 20,000	156,000
Jos	-	1 x 4,000	4,000
TOTAL	9 Buses	6 Buses	**168,000**

With the reallocation of the buses done, we prepare a revised contribution analysis to see if there could be any improvement in the profitability position of the transport company as a result of the reassignments. This is done in the same way as with the computations for the initial expected contributions except that no proportional measurement will be used. All figures are used multiplied straight as indicated in the computation layout below:

From Lagos Deport (Available now = 66) To:

City	Number	Contribution	Total Contribution
Aba	10	115,920	1,159,200
Enugu	15	117,000	1,755,000
P/H	13	132,840	1,726,920
Calabar	12	162,840	1,954,080
Onitsha	16	105,000	1,680,000
	Total from Lagos Depot		**8,275,200**

We shall also carry out similar calculations for other depots using the finally assigned number of buses for each route. The final contribution expected from all routes is given in table 8 bellow:

TABLE 8: FINAL EXPECTED CONTRIBUTIONS BY DEPOTS

DEPOT	CONTRIBUTION
Lagos Depot	8,275,200
Ibadan Depot	2,597,400
Ilorin Depot	2,188,020
Kano Depot	7,155,420
Jos Depot	2,079,540
Total Gross Expected Contribution	**22,295,580**
LESS COST OF REALLOCATION	168,000
TOTAL FINAL EXPECTED CONTRIBUTION	**22,127,580**

DISCUSSION

From the final expected contribution figure, it is clear that our little exercise has yielded a very big positive result. The difference between the initial and final figures from the analysis bellow clearly indicates that the optimal decision has been reached:

TABLE 9: COMPARISON OF INITIAL AND FINAL CONTRIBUTIONS

DEPOT	INITIAL	FINAL (LESS COSTS)	DIFFERENCE	REMARK
Lagos	6,770,618	8,119,200	1,348,582	INCREASE
Ibadan	2,350,028	2,589,400	239,372	INCREASE
Ilorin	2,188,020	2,188,020	-	NO CHANGE
Kano	7,155,420	7,155,420	-	NO CHANGE
Jos	1,975,563	2,075,540	99,977	INCREASE
TOTAL	**20,439,649**	**22,127,580**	**1,687,931**	INCREASE

In this paper, we simplified the case study by making the number of vehicles required equal to the number of passengers to convey. In real life this is not always so. You may have a situation where vehicles are more than the required passengers at all depots or where passengers are more than the required vehicles at all depots. In these two situations, no reallocation of vehicles is required as the optimal decision has already been made by the situation on ground. However, in the case where two depots with short falls are equidistant from a depot with a surplus of vehicles, the determination of which depot is satisfied first rests squally on the value of the shadow contributions to be calculated on all unsatisfied routes in the needy depots (Lucey, 1996; Stafford, 1981). This later exercise is unfortunately outside the scope of this paper.

Table 9 above clearly indicates that the reallocation exercise produced additional overall contribution of N1.687m just for one home bound operation. If the peak period persists as it always do, the bus company will be talking in terms of multiples of such surplus profits. We have considered only the homebound journey peak periods in the above analysis, normally all transport operators have the peak periods both ways – the home bound passengers and the return journey passengers. Just as you can make transfer from one destination depot to another, you can also make transfers from one originating depot to another using exactly the same basis and cost implications as in this case study.

Conclusion

Passenger transport service business in Nigeria is a very big and competitive one. It is easy to make quick profits and it is also easy to pack-up. The guiding principle is to adopt the best and most dynamic approach to administration especially in the area of scarce resource or limiting factor management. Application of the transportation management model algorithm will be a very good step in the right direction.

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