SIMULATING PORT HARCOURT CITY
MASS TRANSPORTATION PROBLEM

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ABSTRACT
Transportation in engineering deals with the movement of goods and people. In this work transportation as a major problem in Nigeria and Port Harcourt city axis in particular is identified. The major types of transportation were road, water, rail and air in the country were discussed. How the oil industry has contributed to the congestion of Port Harcourt and that government controlled bus transportation system is the solution is identified. The transportation problem is a queuing problem and requires simulation solution; hence computer is used to solve this problem. Therefore, in this research work computer software was developed to tackle the problem. Some constraints were established and the developed software was tested with life data to ascertain the usefulness of the computer programme and a print out is included. Finally, conclusions and comments were made on the research work and areas government should assist are also stated.

INTRODUCTION
Transportation is a process whereby goods and labour (people) are moved from one point to another to provide service. The major types of transportation are highways, water, rail, subway, air and pipeline. If the transport system of a society is not efficient, it affects all facets of the society (manufacturing, government work, and schooling, in short immobility of labour and materials leads to inefficiency. Efficient road transportation system is very vital to the economic development of any nation because goods and transport system are necessary inputs for any meaningful development in any economic developmental unit (Seem, 1979) the socio-economic links which many nations have today would not have been possible without transport links between them. Transportation can therefore be called a catalyst that helps to improve human existence on earth. It is a known fact that movement which is the daily ebb and flow of people and traffic, knits the social areas and functional zones of the metropolis into an integrated whole. An efficient transport system

facilitates easy communication in any society and it also saves time spent at any giving point at bus stop (Handcock, 1939) the importance of efficient transport in any society cannot be over emphasized, for it does not only convey people from their origin to destination at any given time, it also take care of that of equipment etc used by the people too. Road is always the best because it depicts the level of economic development a country has attained. Provision of good roads enhances efficient transport system in any where in the world unlike other forms of transport system; roads can transverse every nook and corner of the country thereby stimulating the distribution of ideas and facilities (Okpalla, 1979) consider the socio-economic importance of good roads in the country and in particular the Port Harcourt City axis.

The development of transportation in Port Harcourt has been gradual. Transportation is a queuing problem. The non-availability of efficient transport system within the Port Harcourt axis affects the economy of the area. People go to work late and goods are not easily transported, hence there is loss of man-hours of labour and as well as loss in revenue. This is the problem to be solved in this paper. The advent of computer has assisted in the analysis and solving of complex engineering and management problems. Transportation problem is in this category; hence the computer is used to solve this problem. Port Harcourt is the capital of Rivers State, it is the second largest seaportin Nigeria and it is the operational headquarters of many oil companies in Nigeria. Now, it is the headquarters of the newly established Niger Delta Development Commission (NDDC) and this will further increase the congestion problem in the City. Outside Lagos, Port Harcourt is the most industrialized city in the country. The necessity of providing an efficient transport system to improve productivity in the Port Harcourt axis cannot therefore be over emphasized.

TRANSPORTATION IN PORT HARCOURT CITY

Studies have shown that different works has been done by many Scientists who tried in their various studies to find ways to an efficient transport system in their societies. Their greatest attention was given to road because of its wide coverage in any country. This is because of its importance as a mode used by majority of the people. Road transportation is the most common type of transportation so far. In many cases, it is the only suitable or available form of transportation, with cars, buses, vans,(trucks) and motorcycles as the main modern road vehicles.

In areas well served by roads they can provide a variety of transportation by whatever route they choose and they also provide door-to-door freight service (Ogundara, 1972; Lugard, 1992).

Following the creation of Rives State in May 1967 the then Governor Commander A. Diete-Spiff thought it necessary to diversify the activities of government to embrace as many areas as possible to improve the peoples' welfare. These included the establishment of industries like West African Glass Industry, Rison palm, hospitals, educational institutions and others. Also the discovery of crude oil in commercial quantity in Nigeria (Rivers State Dairy, 1999) has contributed to the traffic congestion in Rivers State particularly Port Harcourt the state capital and also the headquarters of many oil companies. This has led to population drift towards Port Harcourt city, causing the city to be over populated. The consequence is traffic congestion in the city. The city is accessible by land, sea, rail and air but the most important type of transportation is by land, as it is very necessary to move workers and goods within the axis of the state capital. On land several different types of vehicles are used for transportation including different types of private cars, lorries, trucks, taxis, buses of different types and sizes. Bus transportation tends to move more people at a time than any other source. As stated above that the level of land transportation indicates the level of development of the area, government has to come in for the control and improvement of transportation. This research work is focused on government control and implementation of an efficient mass transit bus transport system. Bus transportation is the cheapest in this country because the union and government control it. In the developed countries detailed studies carried out gave rise to their present reliable and efficient transport system. This can be done in our country, if the government has the political will.

SOLUTION TO PORTHARCOURT CITY MASS TRANSPORTATION PROBLEM

The aim of this work is to come up with an efficient and realistic solution to the transportation problem in Port Harcourt city and its environment. The use of government controlled public bus transportation system is identified to be the necessary solution. The transportation problem is a queuing problem, hence it will obey all the conditions for this type of problem. A queening system is a system where entities (customers, parts, passengers, etc) arrive and require a service.   The simplest queuing

system contains a single service channel as shown in figure1, this suits the transportation problem being discussed in this paper.
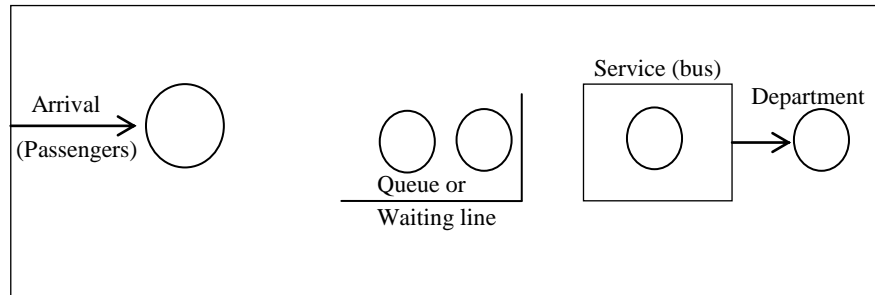
The main aim of this work is to minimize passengers waiting time at bus stops; hence transportation problem is an optimization one. Therefore, certain key elements necessary in seeking an optimal solution have to be identified. Some of there elements are: (1) definition of system boundary – mass transportation in Port Harcourt axis, (2) criterion – minimization of waiting time at bus stops; (3) identification of independent and dependent decision variables of the problem; (4) setting up condition for the study.

Some of the decision variables that need to be determined are: (1) number of bus stops; (2) number of buses available; (3) arrival rate of passengers; (4) arrival rate of buses; (5) departure rate of buses; (6) number of passengers carried per bus at a time; (7) number of passengers waiting at a bus stop for bus (service); and (8) number of trips/bus top/day. In this study it is very clear that decision variables like (3) to (4) and (7) are uncontrollable hence the need of the simulation solution. To simplify and make the problem more realistic certain assumptions have to be made. Some of these assumptions are:

1)   Waiting time by passengers is known and varies within certain limits.

2)   Time spent by buses between bus stops is known and varies within certain limits.

3)   Main transport routes, bus stops, transport zones are known.

4)   Cost of transportation per transport zone is known.

5)   All buses are of the same capacity.

6)   At the start of any trip the system is empty that is, there are no people waiting for service, hence the probability of having people in the system $(P_n = P_o) = 0$

7) $\lambda = \mu$ and traffic density, $p = \lambda / \mu = 1$

8)   Loading time of each bus is known and it is known and constant.
9)   Maximum working hours per day and working days per month are known.

To provide realistic and sensible solution some physical and practical readings and records were taken; like main bus routes, bus stops, time spent at bus stops etc.

THEORETICAL CALCULATIONS

Based on the above assumption certain quantities can be calculated that are relevant in this study.

- Let the longest identified transport route have three (3) transport zones and fourteen (14) bus stops.
- Let the loading time at each bus stop = 2 minutes
- Let the time spent between two bus stops = 10 minutes.
- Let the maximum bus working hours per day = 18 hours
- Let minimum working days in a month = 25 days.
- Let maximum waiting time of a passenger = 12 minutes
- Loading time at 14 stops = 14 x 2 min. = 28 minutes
- Running time of route = (14 – 1) x 10 minutes = 130 minutes
- Total time for one day = (28 + 130) minutes = 158 minutes
- Time for a trip = (188 x 2) minutes = 316 minutes
- Maximum number of trips bus = 18 x 60 / 316 = 3 trips
- Number of required stops bus = 18 x 60/12 = 90 stops
- Required number of buses 90 / 3 = 30 buses
- So, if government provides the 30 buses per day within the conditions set there will be no congestion in the city.
- Let the size of a bus = 50 passengers
- Number of passengers carried/day = 50 x 30 x 2 = 3,000
- Let the transport fare per transport zone = N10.00
- Therefore, daily revenue = No. of passengers x No. of transport zones x transport cost zone = 3000 x 3 x N10.00 = N90,000.00
- Monthly revenue = N90,000.00 x 25 = N2,250,000.00
- Annual revenue N2,250,000.00 x 12 = N27,000,000.00
- Knowing the revenue generated the viability of the venture can be improved.

COMPUTER SOFTWARE

Optimization problem requires simulation and as the transportation problem is an opportunity to consider several varying conditions to determine the best solution. Computer offers the best service for solving a problem using simulation, hence the necessity for developing this computer software Miller (1981). The series of calculations required are many and only the computer can very well perform these calculations. The computer software is written in BASIC computer language the program calculates and prints the following variables;

1. The required number of buses to minimize passengers waiting time at bus stops based on variable loading and running times for the buses.
2. The total number or income generated per day/month/year.
3. The most profitable transport route.

All these calculations were based on the assumptions stated in this work. At this stage it becomes necessary to use real life situation to test the developed software to establish it usefulness.

AN ILLUSTRATING EXAMPLE – PORT HARCOURT CITY

To test the developed software the transport situation of Port Harcourt and its environ was studied to be used. For a start the major bus transport routes, zones and bus stops were identified as stated below in Table 1.

TABLE 1: MAIN BUS ROUTES

S/No	Route	No. of Bus Stops	No. of Transport Zones
1	Zoo to Park to Borikiri	12	3
2	Oil mill to Park to Borikiri	12	4
3	Rumuokoro – Mile 1 to Borikiri	14	4
4	Mile 1 to Leventis to N.P.A.	6	1

The detailed bus routes are shown in Figure 2

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FIGURE 2: PORT HARCOURT CITY BUS ROUTES

The next stage is to establish waiting time for passengers, loading time for buses and time used by buses in between bus stops. For this work the following conditions were set: (1) the loading time for passengers varies from 2 to 10 minutes; (2) the time between bus stops varies from 4 minutes to 20 minutes in steps of 2 minutes; (3) the maximum waiting time of a passenger is dependent on the Operator.

The computer operator will be required to provide the following information while interacting with the software; (1) the transport fare in Naira per zone; (2P the capacity of a bus, that is the number of passengers the bus can carry; (3) maximum number of routes and their zones; (4) maximum number of bus stops/route; (5) maximum working hours/day for a bus; (6) names of main bus routes; (7) minimum working days in a month; and (8) maximum waiting time for a passenger. In short eight sets of information will be requested from the operator. After this the computer does all the necessary calculations and print what is necessary onthe screen and if also instructed it produces a hard copy from the computer printer. Typical computer print out and the computer software are available for usage.

RECOMMENDATIONS

Given the foregoing discussions, it is acceptable that;

1. Transportation is a major problem in the Port Harcourt City axis and require an efficient solution.
2. Government controlled bus transportation system is the ideal efficient solution.
3. Transportation is a queuing problem, so require a simulation solution, hence the use of computer in proffering a solution is necessary and justified.
4. The developed computer software in BASIC language is efficient and useful.
5. From the print-out of revenue to be generated it is clear that the programme can maintain itself.
6. If government judiciously follows the solution of this program the congestion problem in Port Harcourt will be solved.
7. As many buses are involved, it is necessary for this research work to extend to cover the maintenance programme for the buses.
8. The use of computer facility should be extended to cover the maintenance of the buses used in the transportation programme.
9. Also to tangle this problem the time for opening of offices, schools, colleges or Universities in the morning hours may be varied.
10. To reduce the traffic congestion problem in Port Harcourt government should establish more link roads to reduce the pressure on Ikwerre and Aba Roads.

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