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Computation Of Vehicle Allocation, Scheduling and Number of Commuters in Selected Nigerian Routes

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Abstract

The research is aimed at developing a transport management algorithm that will be used to determine the number of commuters and vehicular allocation with high numerical accuracy. Many research works have proposed either using machine learning algorithms for clustering, classification, determination of frequent item-set in datasets (databases) or traditional algorithms to effectively design transportation systems. In this research a non-machine learning algorithm that does not require any training time, which will require less computation power and increase process execution time is developed. The scheduling algorithm is designed taking note of two most important variables: the number of commuters is the independent variable and the number of buses assigned or schedule to a designated route is the dependent variable. Some decision assumptions are made which include all vehicle used in the research have same carrying capacity for all the routes. The algorithm numerically computes the number of commuters, the number of assigned vehicles and the number of scheduled vehicles for each route. So, the research will assist in making useful deductions such; number of resources required to effectively service a route without bottle-necks and more accurately the size of input per route and approximate output for the corresponding routes. The results show the total number of vehicles assigned, scheduled and number of commuters on a text file (document).

Keywords: ***Assigning, Commuters, Scheduling, Transportation, Routes.***

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INTRODUCTION

All world economies hover around efficient transportation be it land, air, water and any other form for the movement of goods and services across the globe. Transport is one of the most significant branches of social production and it is designed to meet the demands of the population in transportation (Dermenzhi *et al*., 2021). There is need to pay proper attention to road transportation system being the most common form of transportation. Therefore, there is need to take a critical analysis, assessment and development of a seamless transportation management system.

Many researchers have emphasized on effective design and implementation of transportation systems. Al-Hawari *et a*l. (2020) discussed many aspects related to the design, development, and testing of an online-based information system that is aimed at the facilitation of the management of a bus transportation service. El-Mohsen and Zorkany (2018) designed and implemented a collision avoidance and emergency warning system. The proposed framework for the system combines on-board unit development with publicly available inter-vehicle wireless messaging systems and also positioning devices. A transmission routing scheme is proposed based on multi-hop distributing scheme with a dissemination model and a suppression method. Ullah *et al.* (2019) used GPS (Global Positioning System) to track the nearest location of the vehicle and police station; a sensor is used for checking seat availability. Also use a Panic Alert Button on every seat of the bus to reduce female harassment. With the press of the panic alert button, the notification sends to the owner and the nearest police station with the current location of the vehicle. In this research rather than only dwelling on the design and implementation of an effective road transport system, the number of buses scheduled and assigned to designated routes are computed numerically which will help investors in resources allocation for utmost efficiency and effectiveness.

Some of the findings and their corresponding contribution to the transportation sector are critically examined. Cats and Gluck (2019) computed both frequency and vehicle capacity at the network level while taking into cognizance the major effect of service variations on commuters and operator costs. Shang *et al*. (2019) developed an extensive vehicle scheduling model, taking into consideration the interests of commuters and operators in achieving optimization of timetable synchronization integrated with vehicle scheduling and considering the passenger waiting cost. Shehu *et al*. (2020) provided varied methods for solving a frequency setting (FS) for transportation problems. Bie *et al*. (2020) proposed a mixed scheduling technique combining the all-stop service and the stop-skipping service to optimize scheduling strategies for multiple routes by reducing total passenger travel time. Sadrani *et al*. (2022) developed a mathematical modeling framework to optimize service frequency and vehicle size for automated vehicle systems, while taking into consideration both user and operator costs. Wagale *et al*. (2013) presented a model to optimize the bus scheduling by taking into consideration both bus stop and route segments of the city in an integrated manner. Asplund (2021) used the square-root rule to estimate the optimal vehicle frequencies in the case city of Uppsala. Esfeh *et al*. (2021) developed a concise approach to determine the mean waiting time of commuters. Jaramillo *et al*. (2013) presented a design of networks of bus routes showing the overview and background of suitable optimization models for the entire populace transportation system. Zhang *et al.* (2020) built a model of transit route network design for low-mobility individuals using hybrid metaheuristic approach.

This research will compute the volume of commuters per route and also use an eighteen setter bus as a measuring variable to determine the number of vehicles scheduled and assigned to a route. In this research the number of commuters for the designated routes, the number of buses schedule for each route and the total number of buses assigned to a given route were all computed.

MATERIALS AND METHODS.

Data Collection

The data used for the analysis is collected from three leading transportation companies in Abuja. The companies are ABC, Young Shall Grow and Teille motors.

Scheduling Agorithm

The scheduling algorithm used is an adoption and modification of hybrid metaheuristic approach (Zhang *et al.*, 2020) which made useful assumptions like the number of routes being constant, the origin and destination stops of each transit route are known, the maximum transit fleet size available for public transportation is fixed, the load capacity of each vehicle is same. Also the Vehicle Scheduling Optimization which applied Passenger Waiting Cost model (Shang et al., 2019) has useful assumptions that were adopted like setting of routes, scheduling horizon, deficit number of vehicles and peak periods.

The vehicle scheduling algorithm descibed in this research has an input meduim which stores the data collected. There is a maximum variable declared and used to check when a bus is full to its carrying capacity this assist in vehicle assignment (allocation), while the minimum variable helps to schedule a vehicle once the average carrying capacity is attained for a designated route. The number of routes are known, the distance between routes is not taken into consideration, transportation cost is also not considered. A quotient variable is used to perform bus allocation, scheduling operations and then implementation of the algorithm using C programming Language. The scheduling algorithm is thus represented:

1. Start
2. Set maximum and minimum counters
3. Set routes
4. Declare Remainder and Quotient
5. Declare assign a bus and schedule a bus
6. Declare no bus schedule
7. Assign schedule-no-bus to zero
8. Set quotient counter to zero
9. Set assign a bus counter to one
10. Assign values to min and max
11. Read the number of commuters for each route from the text file
12. Assign number of commuters to each route
13. Commuters< max&&commuters >=min
14. Schedule a bus
15. Remainder = number of commuters per route% max
16. Remainder >=min && Remainder < max
17. Schedule a bus
18. Quotient = number of commuter per route / max
19. Quotient >= 1 && Quotient < 2
20. Assign a bus
21. Increase quotient counter by 1.
22. Increase assign-a-bus counter by 1
23. If Quotient >= 4
24. Declare route viable
25. Output results.
26. Stop

RESULT AND DISCUSSION

Table 1: Monday Results

ROUTE NAMES	ENUGU	LAGOS	UYO	BENIN	OWERRI	ONITSHA	CALABAR	ABA
COMMUTERS	78	79	47	66	85	98	41	106
REMAINDER	6	7	11	12	13	8	5	16
SCHEDULE	0	0	1	1	1	0	0	1
BUSES ASSIGN	4	4	2	3	4	5	2	5
TOTAL NUMBER OF BUSES SCHEDULE FOR MONDAY 4								
TOTAL NUMBER OF BUSES ASSIGN FOR MONDAY 29								

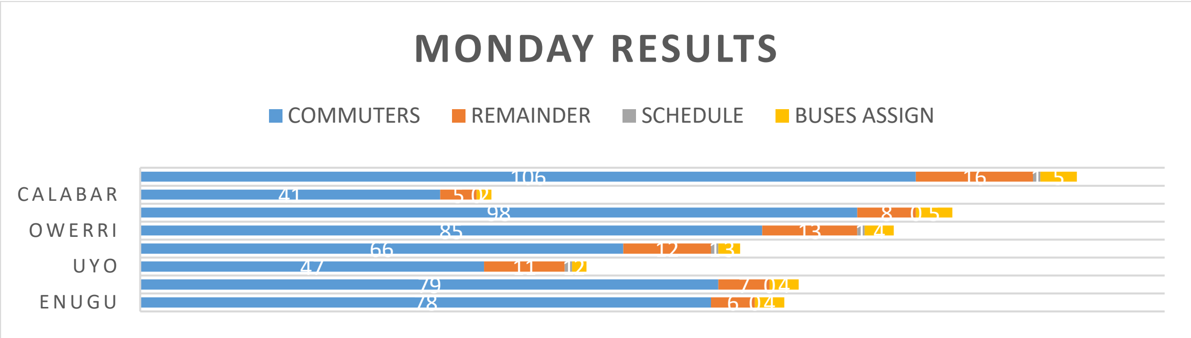

Figure 1: Pictorial representation of Monday results.

Table 2: Tuesday Results

ROUTE NAMES	ENUGU	LAGOS	UYO	BENIN	OWERRI	ONITSHA	CALABAR	ABA
COMMUTERS	183	55	57	67	86	95	53	95
REMAINDER	3	1	3	13	14	5	17	5
SCHEDULE	0	0	0	1	1	0	1	0
BUSES ASSIGN	10	3	3	3	4	5	2	5
TOTAL NUMBER OF BUSES SCHEDULE FOR TUESDAY 3								
TOTAL NUMBER OF BUSES ASSIGN FOR TUESDAY 35								

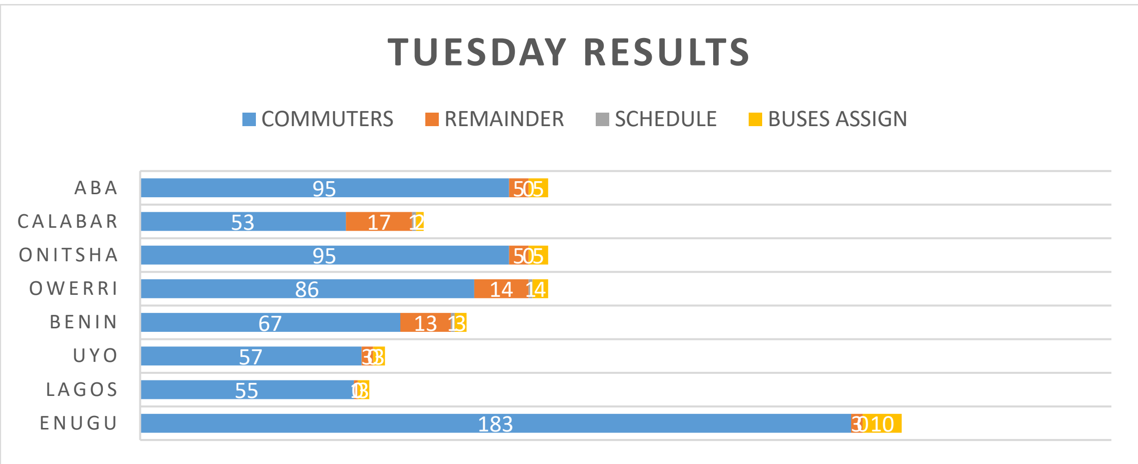

Figure 2: Pictorial representation of Tuesday results.

Table 3: Wednesday Results

ROUTE NAMES	ENUGU	LAGOS	UYO	BENIN	OWERRI	ONITSHA	CALABAR	ABA
COMMUTERS	103	43	67	82	71	66	53	92
REMAINDER	13	7	13	10	17	12	17	2
SCHEDULE	1	0	1	1	1	1	1	0
BUSES ASSIGN	5	2	3	4	3	3	2	5
TOTAL NUMBER OF BUSES SCHEDULE FOR WEDNESDAY 6								
TOTAL NUMBER OF BUSES ASSIGN FOR WEDNESDAY 27								

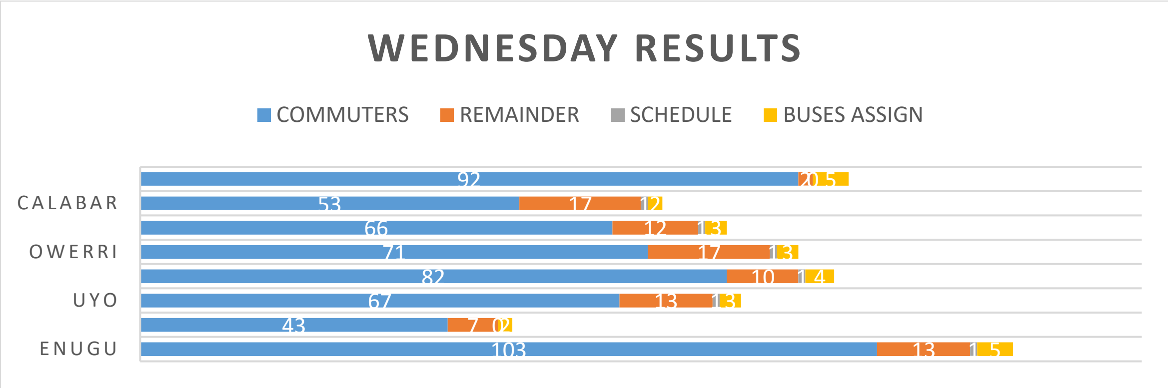

Figure 3: Pictorial representation of Wednesday results.

Table 4: Thursday Results

ROUTE NAMES	ENUGU	LAGOS	UYO	BENIN	OWERRI	ONITSHA	CALABAR	ABA
COMMUTERS	96	55	64	67	80	66	47	71
REMAINDER	6	1	10	13	8	13	11	17
SCHEDULE	0	0	1	1	0	1	1	1
BUSES ASSIGN	5	3	3	3	4	3	2	3
TOTAL NUMBER OF BUSES SCHEDULE FOR THURSNDAY 5								
TOTAL NUMBER OF BUSES ASSIGN FOR THURSDAY 26								

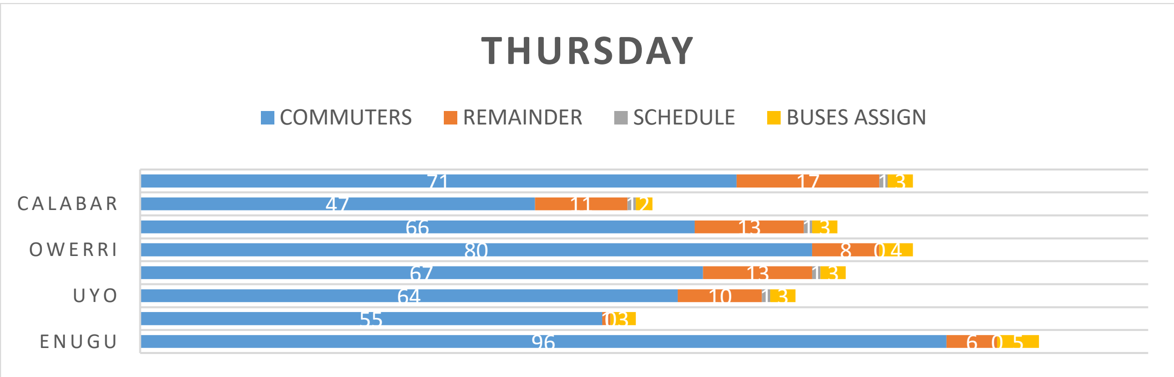

Figure 4: Pictorial representation of Thursday results.

Table 5: Friday Results

ROUTE NAMES	ENUGU	LAGOS	UYO	BENIN	OWERRI	ONITSHA	CALABAR	ABA
COMMUTERS	223	81	73	99	94	144	83	124
REMAINDER	7	9	1	9	4	0	11	16
SCHEDULE	0	1	0	1	0	0	1	1
BUSES ASSIGN	12	4	4	5	5	8	4	6
TOTAL NUMBER OF BUSES SCHEDULE FOR FRIDAY 4								
TOTAL NUMBER OF BUSES ASSIGN FOR FRIDAY 48								

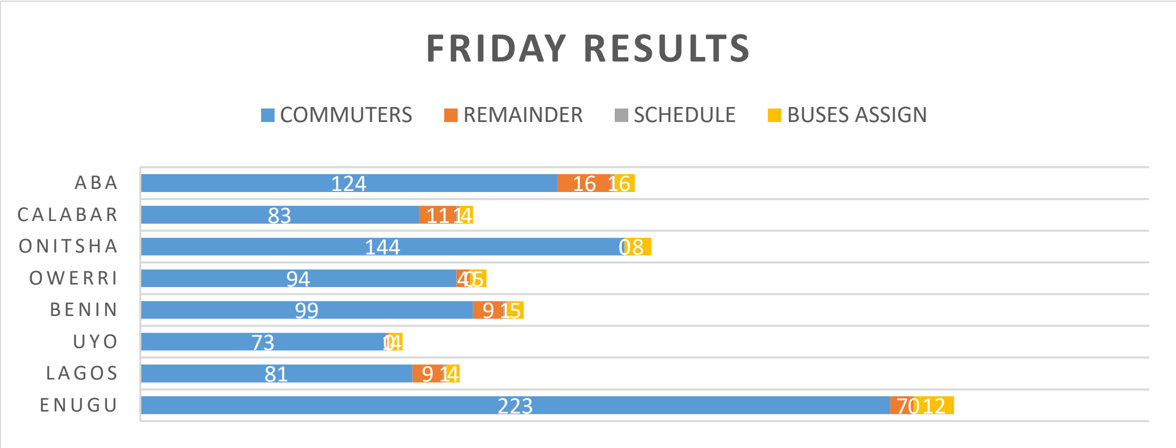

Figure 5: Pictorial representation of Friday results.

Table 6: Saturday Results

ROUTE NAMES	ENUGU	LAGOS	UYO	BENIN	OWERRI	ONITSHA	CALABAR	ABA
COMMUTERS	214	101	90	98	120	363	86	100
REMAINDER	16	11	0	0	12	3	14	10
SCHEDULE	1	1	0	0	1	0	1	1
BUSES ASSIGN	11	5	5	5	6	20	4	5
TOTAL NUMBER OF BUSES SCHEDULE FOR SATURDAY 5								
TOTAL NUMBER OF BUSES ASSIGN FOR SATURDAY 61								

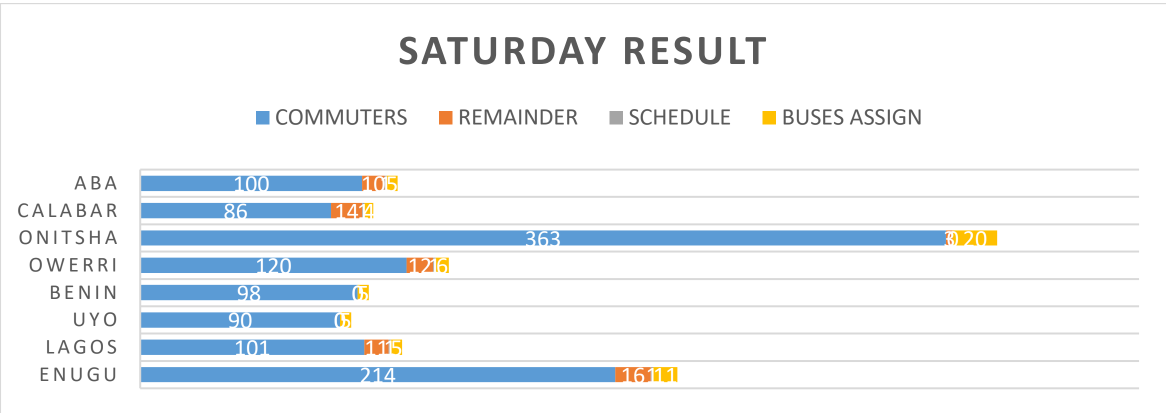

Figure 6: Pictorial representation of Saturday results.

Table 7: Sunday Results

ROUTE NAMES	ENUGU	LAGOS	UYO	BENIN	OWERRI	ONITSHA	CALABAR	ABA
COMMUTERS	68	54	43	61	69	70	34	76
REMAINDER	14	0	7	7	15	16	16	4
SCHEDULE	1	0	0	0	1	1	1	0
BUSES ASSIGN	3	3	2	3	3	3	1	4
TOTAL NUMBER OF BUSES SCHEDULE FOR SUNDAY 4								
TOTAL NUMBER OF BUSES ASSIGN FOR SUNDAY 22								

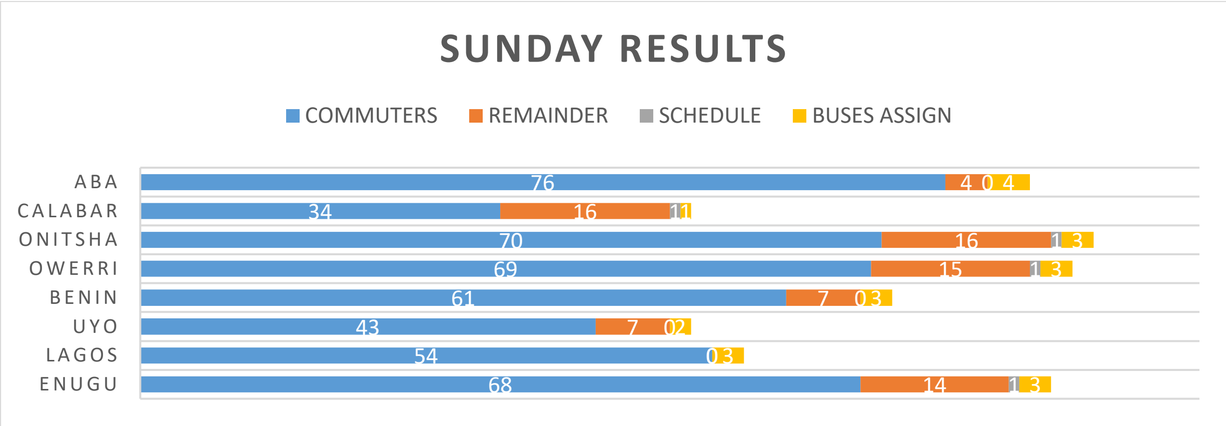

Figure 7: Pictorial representation of Sunday results.

The results show routes with high, average and low volume of commuters for an entire week across the three transporting companies. Performing a summation computation for the three routes makes the data less sparse even when the data is taken for a short period of time. It can be seen from the tables and charts that the volume of commuters is directly proportional to the number of vehicles assigned and scheduled to a given route. From the result it can also be noticed that the number of vehicles schedule is not a function of the volume of commuters in a route, the scheduling module performs a remainder operation of an integer division of eighteen which is the number of commuters for an assignment. So, once the remainder is fifty percent which in this research is nine a bus is scheduled.

While Cats and Gluck (2019) solve the deteriorating comfort on board a crowded vehicle problem, including those denied boarding in case of insufficient vehicle capacity and also improve service headway fluctuations resulting from flow-dependent dwell time variations, this research focuses on computation of the volume of commuters for the designated routes, then using the number of commuter to determine the scheduling and allocation of vehicle. Shang *et al.* (2019) used deadheading passenger bus plan and deficit algorithm to harmonize passengers waiting cost and vehicle scheduling to improve efficiency. From the result only one bus is scheduled at any instance but the frequency of buses assigned continue to vary depending on the volume of commuters.

The results also shows the total number of vehicles assigned and scheduled daily for all the designated routes. Also from the chart it can be seen that there is a significant increase in the number of commuters at the beginning of the week and weekend. So, from this result it can be interpreted that transportation or movement of people surge seasonally.

CONCLUSION

The algorithm accurately computed the number of commuters, the number of commuters for scheduling to be made and bus allocation for the eight routes. The variation in the volume of commuters will assist transporters to make adequate resources are made available in time of surge. Also transporters will be able to project an appropriate budget needed to run a route(s), once the price of a bus is known, the cost for the number of buses required can easily be computed. Likewise the number of ticketing, loading and driving staff can easily be appropriated. Also the cost of maintaining the staff while still being in a comfortable profit margin can easily be computed from the number of staff.

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