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(RESEARCH ARTICLE)

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Fleet size and traffic flow rate dimensions of the University of Port Harcourt mass transit system

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Abstract

The University of Port Harcourt, Rivers State, Nigeria is rapidly developing and expanding in spatial size, thus, leading to upsurge in population of staff, students, business owners and visitors. Consequently, there is the growing concern that with the current state of perennial buildup of traffic along the main entry and exit routes of the main campus; occurrence of major mobility crises, especially during the traffic peak-hours is only a matter of time. To make for better understanding and appreciation of the current traffic conditions, the precariousness of the near future and to recommend appropriate measures towards arresting the situation, this study became necessary. The paper evaluates the traffic characteristics of the study area using such temporal parameters as traffic volume, on/off peak traffic periods and traffic flow rate for 5 work-days of the week. For the traffic flow rate, the study revealed high volume of traffic within 1.5 kilometers network. This gave the average values of 8.8, 8.5, 8.2, 6.8 and 8.1 vehicles per minute in a 5-day count, for the morning peak-hour, between 8 and 9am. Similarly, evening peak-hour (4-5 pm) gave the average values of 5.8, 5.4, 5.1, 4.9 and 6.2 per minute. Fleet size was an average of 245 vehicles per day. The geometric features of the road networks, traffic volume and fleet size invariably contribute to the perennial gridlock at peak-hours. Values were obtained through the Gordon line traffic survey carried out on the five work-days of the week, consecutively.

Keywords: Travel time; Fleet size; Traffic flow-rate; Peak hour

1. Introduction

One major problem of rapidly growing population in any given space is mobility crises (Obadina & Akinyemi; 5; Aderamo & Atomode, 2). An area of spiking development rate, such as the University of Port Harcourt, Rivers State, Nigeria needs to give adequate consideration to her transportation network development. Otherwise, the inevitable consequence would be huge wastage of costly man hours and hampered productivity of her workforce.

In the area of study, the transportation network is gradually being chocked by increasing traffic volume, too many pick and drop points and poor network geometry. The commuting distance has also increased with the alteration of the features of the feeder road; the east-west road. Adanitkin, Olutaino & Obafemi (1) observed that timely and efficient transportation is largely dependent on the performance of the transit system, which is directly related to the traffic characteristics of the route.

Given the backdrop of increasing traffic volume, vis-à-vis the hike in population, there is the need for the evaluation of the operational characteristics and performance of the mass transit service in the institution. This is with a view to providing informed details for proactive management of the transit system. To achieve the purposes stated above, Gordon Line Traffic Survey was carried out to obtain the traffic volume, average fleet size, peak/off peak hours and the traffic flow rate of the area of study.

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2. Study Area

The University of Port Harcourt is a second-generation Nigerian university predominantly located in Choba community of Rivers State, Nigeria. The university is bounded in the west by the New Calabar River, in the east by Rumuekini community, in the north by Omuoko and Omuokiri communities and the west by Choba and Alakahia communities. The university is situated between latitudes 4.9069° N and longitude 6.9170° E. There are 3 campuses of the University: Choba, Delta and Abuja. The Delta Park – Unipark road is an internal single lane road network starting from the Delta entrance gate to the UPTH inner gate.

The current population of the university is put at about 40,000 students, at all levels of studies and about 6,000 members of staff in various service cadres. This gives a total population of about 46,000 persons, excluding daily visitors, contractors and business owners.

3. Methodology

For this study, four research assistants were commissioned from members of the University Taskforce on Enforcement of Minimum Operational Standards on Campus Shuttle services and students. Gordon line survey was carried out at Ofrima Roundabout, being the most strategic location through which every commercial vehicle coming from any of the parks or campuses of the university passes. The timing of trips from Delta Park and Choba Park to Unipark was also done. These exercises held from Monday to Friday, 8am to 6pm each day. From the operational records of the Management of the Parks, fleet size was obtained. Data bordering on vehicle occupancy rate, traffic volume and traffic flow rate were obtained through the traffic count exercise.

The following formulas were used for analysis:

$$\text{Traffic flow rate } = \frac{\sum \text{No. of vehicles}}{\sum \text{time (minutes)}}$$

Average fleet size (Chien, et al. (4) $= No.of\ vehicles\ (day\ 1) + No.of\ vehicles\ (day\ 2) + No.of\ vehicles\ (day\ 3) + No.of\ vehicles\ (day\ 4) + No.of\ vehicles\ (day\ 5) \div No.of\ days\ of\ exercise\ (5)$

4. Results and discussion

Table 1 Fleet Size and Characteristics

Days	No. of active vehicles
Day 1	257
Day 2	242
Day 3	235
Day 4	238
Day 5	254
Total	1223
$Average\left(\frac{1223}{5}\right) = 245.2$	

Average daily fleet size = 245.2 vehicles per day.

4.1. Gordon Traffic Count

Tables below show the result of the 5-days Gordon count of inbound and outbound traffic. The counting followed an hour interval rule of 8-8am, 9-10am, 10-11am, 11-12noon, 12-1pm, 1-2pm, 2-3pm, 3-4pm, 4-5pm and 5-6pm (i.e. 10 hours).

Table 2 Result of Traffic Count/Survey for day 1 (Monday): Day 1 = 257 vehicles

S/N	In – Bound	Outbound	Time	Aggregate
1	479	53	8 – 9 am	532
2	451	48	9 – 10 am	499
3	206	45	10 – 11 am	251
4	114	22	11 – 12 pm	136
5	83	18	12 – 1 pm	101
6	68	44	1 – 2 pm	112
7	62	155	2 – 3 pm	217
8	50	268	3 – 4 pm	318
9	32	303	4 – 5 pm	335
10	28	322	5 – 6 pm	350
Total	573	1278	10 hours	2851

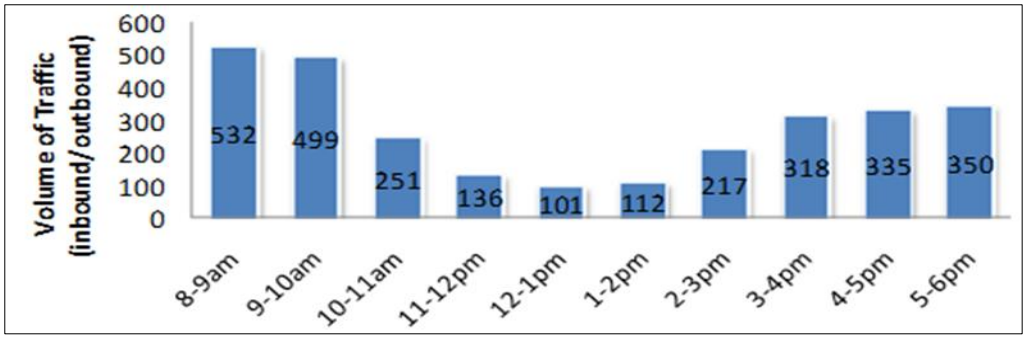

Figure 1 Hourly traffic volume for day 1

The figure 1 above shows that the morning traffic peak hour is 8-9am (532 vehicles/hour). The evening peak hour is 5-6pm (350 vehicles/hour). The off-peak hour is 12-1pm (101 vehicles per hour). This finding supports Atomode (3) which noted that traffic congestion is associated with traffic volume with the worse conditions often experienced during the morning peak period.

4.2. Determination of traffic flow

$$Traffic\ flow\ = \frac{No.of\ vehicles}{Time\ (minutes)}$$

$$So, 8-9\ am\ (morning\ peak\ hour) = \frac{532}{60} = 8.8\ per\ minute$$

$$5-6\ pm\ (Evening\ peak\ hour) = \frac{350}{60} = 5.8\ per\ minute$$

$$12-\ 1\ pm\ (off\ peak\ hour) = \frac{101}{60} = 1.6\ per\ minute$$

$$Average\ hourly\ traffic\ flow\ rate = \frac{Total\ No.of\ Vehicles}{Total\ time\ takem\ (hrs)} = \frac{532+499+251+136+101+112+217+318+350}{10\ (hours)} = \frac{2861}{10}$$

$$= 285.1\ Vehicles\ per\ hour$$

Table 3 Result of traffic count/survey for day 2. (242 vehicles)

S/N	In-bound	Out-bound	Time	Aggregate
1	425	41	8-9 am	493
2	465	45	9-10 am	510
3	201	30	10-11 am	231
4	109	21	11-12 pm	130
5	65	13	12-1 pm	78
6	43	39	1-2 pm	82
7	45	120	2-3 pm	165
8	38	243	3-4 pm	281
9	20	288	4-5 pm	308
10	11	317	5-6 pm	328
Total	1149	1157	10 hours	2606

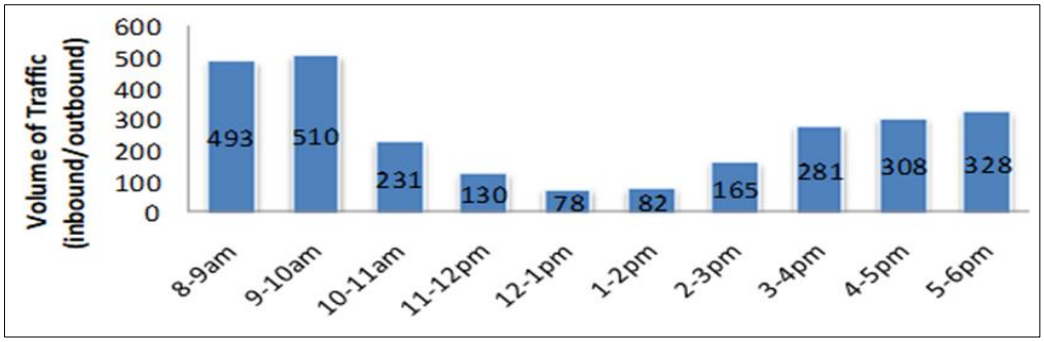

Figure 2 Hourly traffic volume for day 2

Peak hours: The morning traffic peak hour for day 2 is 9-10am (510 vehicles/hour). Evening peak hour is 5-6pm (328 vehicles/hour). off peak hour is 12-1pm (78 vehicles/hour).

$$Traffic\ flow = \frac{No.of\ vehicles}{Time\ (minutes)}$$

$$So, 9-10am\ (morning\ peak\ hour) = \frac{510}{60} = 8.5\ vehicles\ per\ minute$$

$$5-6pm\ (Evening\ peak\ hour) = \frac{328}{60} = 5.4\ vehicles\ per\ minute$$

$$12-1pm\ (off\ peak\ hour) = \frac{78}{60} = 1.3\ vehicles\ per\ minute$$

$$Hourly\ traffic\ flow\ rate: \frac{Total\ No.of\ vehicles}{Total\ time\ taken\ (hours)}$$

$$= \frac{493 + 510 + 231 + 130 + 78 + 82 + 165 + 281 + 308 + 328}{10\ (hours)} = \frac{2606}{10} = 260.6$$

Average traffic flow rate = 2260.6 approximately 261 vehicles per hour.

Table 4 Result of traffic count/survey for day 3 (235 vehicles)

S/N	In-Bound	Out-bound	Time	Aggregate
1	444	40	8-9 am	484
2	450	43	9-10 am	493
3	212	30	10-11 am	242
4	104	15	11-12 pm	119
5	56	9	12-1 pm	65
6	42	28	1-2 pm	70
7	48	100	2-3 pm	148
8	26	239	3-4 pm	265
9	9	255	4-5 pm	264
10	12	297	5-6 pm	309
Total	1403	1056	10 hours	2459

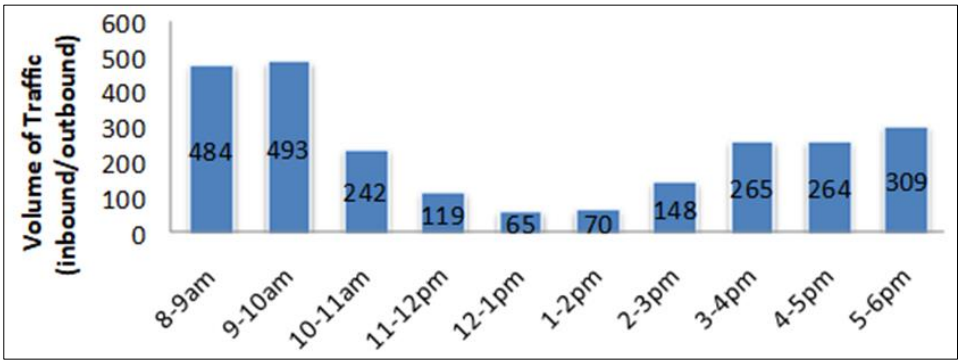

Figure 3 Hourly traffic volume for day 3

4.3. Peak hours for day 3

Morning traffic peak hour is 9-10am (493 vehicles/hour). Evening peak hour is 5-6pm (309 vehicles/hour). Off peak hour is 12-1pm (65 vehicles/hour).

$$Traffic\ flow = \frac{No.of\ vehicles}{Time(minutes)}$$

$$Morning\ peak\ hour\ traffic\ flow\ (9-10am) = \frac{493}{60} = 8.2$$

$$Evening\ peak\ hour\ traffic\ flow\ (5-6pm) = \frac{309}{60} = 5.1$$

$$Off\ peak\ hour\ (12-1pm) traffic\ flow = \frac{65}{60} = 1{,}0$$

$$Average\ traffic\ flow\ rate: \frac{Total\ No.of\ vehicles}{Total\ time\ taken\ (hours)}$$

$$\frac{480\ +\ 493\ +242\ +\ 119\ +\ 65\ +\ 70\ +\ 148\ +\ 265\ +\ 264\ +\ 309}{10\ (hours)} = \frac{2459}{10} = 245.9$$

Approximately 246 vehicles per hour.

Table 5 Result of traffic count/survey for day 4

S/N	In-Bound	Outbound	Time	Aggregate
1	340	51	8-9 am	391
2	362	51	9-10 am	413
3	204	47	10-11 am	251
4	111	22	11-12 pm	133
5	69	15	12-1 pm	84
6	98	16	1-2 pm	114
7	79	50	2-3 pm	129
8	16	205	3-4 pm	221
9	13	284	4-5 pm	297
10	7	259	5-6 pm	266
Total	1299	1000	10 hours	2299

Day 4 = 238 vehicles

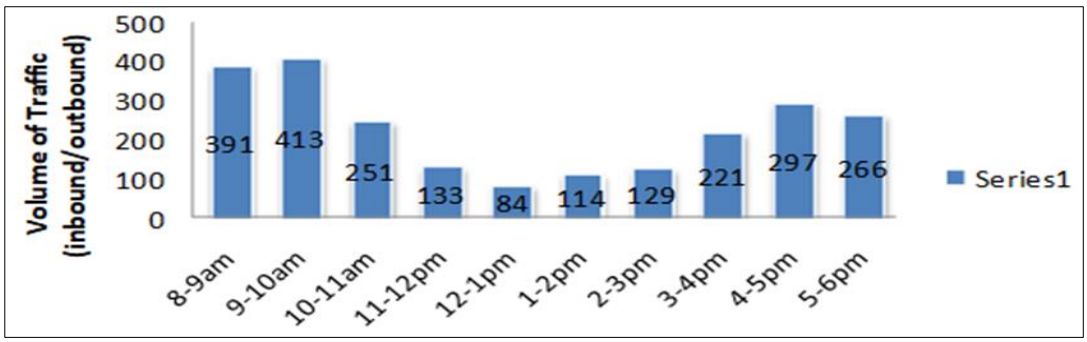

Figure 4 Hourly traffic volume for day 4

4.4. Peak hours for day 4

Morning traffic peak hour is 9-10am (413 vehicles/hour). Evening peak hour is 5-6pm (297 vehicles/hour). Off peak hour is 12-1pm (84 vehicles/hour).

$$Traffic\ flow = \frac{No.of\ vehicles}{(Time\ (minutes)}$$

$$Morning\ peak\ hour\ traffic\ flow\ (9-10am) = \frac{413}{60} = 6.8$$

$$\text{Evening peak hour traffic flow } (5-6\text{pm}) = \frac{297}{60} = 4.9$$

$$\text{Off peak hour } (12-1\text{pm}) \text{traffic flow} = \frac{84}{60} = 1.4$$

$$\text{Average traffic flow rate: } \frac{\text{Total No. of vehicles}}{Total\ time\ taken\ (hrs)}$$

$$= \frac{391 + 413 + 251 + 133 + 84 + 114 + 129 + 221 + 297 + 266}{10\ (hours)} = \frac{2299}{10} = 229.9$$

Approximately 230 vehicles per hour

Table 6 Result of Traffic Count/Survey for day 5. Day 5 = 254 vehicles

S/N	In-bound	Outbound	Time	Aggregate
1	425	38	8-9 am	463
2	453	34	9-10 am	487
3	200	25	10-11 am	225
4	110	18	11-12 pm	128
5	72	31	12-1 pm	103
6	141	225	1-2 pm	366
7	159	217	2-3 pm	376
8	140	263	3-4 pm	303
9	21	247	4-5 pm	268
10	15	221	5-6 pm	236
Total	1636	1319	10 hours	2955

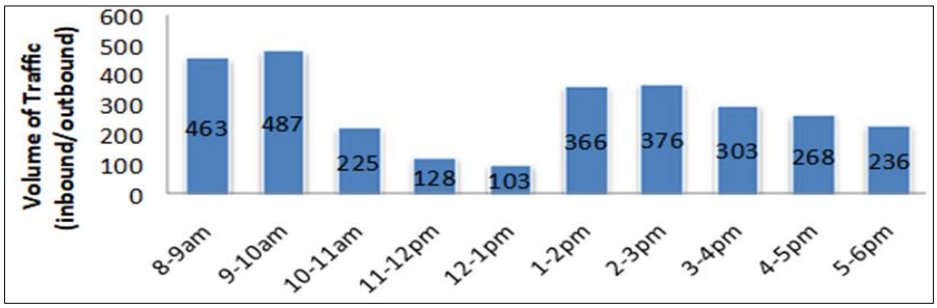

Figure 5 Hourly traffic volume for day 5

4.5. Peak hours for day 5

Morning peak hour is 9-10am (487 vehicles/hr). Evening peak hour is 5-6pm (376 vehicles/hr). Off peak hour is 12-1pm (103 vehicles/hr).

$$Traffic\ flow = \frac{No.of\ vehicles}{Time\ (minutes)}$$

$$Morning\ peak\ hour\ traffic\ flow\ (9-10am) = \frac{487}{60} = 8.1$$

$$\text{Evening peak hour traffic flow } (5-6\text{pm}) = \frac{376}{60} = 6.2$$

$$\text{Off peak hour } (12-1\text{pm}) \text{traffic flow } = \frac{103}{60} = 1.7$$

Average traffic flow rate for day 5 =

$$\frac{463 + 487 + 228 + 128 + 103 + 366 + 376 + 303 + 297 + 268 + 236}{10\ (hours)} = \frac{2955}{10} = 295.5$$

Approximately 296 vehicles per hour

5. Conclusion

From the forgoing it is evident that the transport system in the area of study is being gradually choked with volume of traffic beyond its installed capacity. The volume of traffic (commercial vehicles only) at the morning peak hour which varies between 8-9 am and 9-10 am on week days are as high as 295.5 vehicles, 636 in bound commercial vehicles hours of 8am to 6pm.

The average traffic flow rate is minimum of 296 vehicles per hour on Fridays and a minimum of 230 vehicles per hour on Thursdays. The increased volume on Fridays results from the influx of the Moslems into the mosque in the University between the hours of 12 and 2pm for Jumat prayer and their exit between 2 and 4pm.

The evening peak hour is between 4 and 5pm. The evening peak hour average traffic volume is 6.2 vehicles per hour. Off- peak hour is between 12 and 1pm with 1.7 vehicles per hour. The volume of peak hour traffic is obviously too high for the road network, thereby resulting to traffic bottleneck on the two major gateways into the Unipark campus. These findings corroborate that of Popoola, Abiola, Adenyi, (6) which reported that the causes of traffic congestion are inadequate road capacity and poor road pavement.

Recommendations

Having analysed the characteristics of the networks, the following recommendations are made:

- Dualization of the Delta Gate – Unipark road network to contain the increasing volume of traffic generated by that route.
- Establishment of traffic control points at the Ofrima Roundabout or use of solar powered traffic light.
- Rehabilitation of failed parts of the Unipark-Igbogo Road- Choba route.
- Use of asphalt to reconstruct the Dan-Etete Road leading to IPS/AP axis of the East-West Road. The interlocking stones used on the road makes it uneven and difficult to ply even at minimal speed, thus causing delays.
- Construction of pedestrian walkways (as is being currently done) on the major routes.
- Construction of pedestrian bridges on the Choba Junction and AP/IPS points of the East-West Road.
- Designation and marking of zebra crossing points for the Lulu-Briggs Health Centre, Alex Otti drives by Faculty, of Law building and Faculty of Management Sciences/Senate building bus-stop, and Ofrima Roundabout.
- Designation of bus stops on the Igbogo Road area.

Compliance with ethical standards

Acknowledgment

I acknowledge the support of the operators of the University of Port Harcourt Campus shuttle system, the park management and drivers for assisting with data gathering.

Disclosure of conflict of interest

The author wishes to state that there is no conflict of interest with respect to this study.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by the author.

Statement of informed consent

This study did not involve information about any individual. Therefore, there was no need to obtain informed consent from anybody.

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