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RESEARCH ARTICLE

An Evaluation of Intra-Urban Traffic Issues in Relation to the Road Design and Existing Infrastructure in Enugu Metropolis, Enugu State, Nigeria

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ABSTRACT

Conveying both people and goods from one place to another poses challenges to city authorities with rising population. The aim of this study sought to evaluate the Intra-Urban Traffic challenges in relation to the road design and existing infrastructure in Enugu Metropolis, Enugu State, Nigeria with the objectives of assessing the level of traffic congestion at the peak hours in the study area; evaluating the condition of the existing transport infrastructure and facilities in relation to road designs in the study area; and ascertaining the causes and characteristics of vehicular traffic composition of selected roads in Enugu metropolis. The study revealed that that most of the transport infrastructure and facilities needed urgent repairs, rehabilitation, expansion and reconstruction. Further studies showed that the level of traffic congestion along Ogbete/Holy Ghost axis, Enugu for the observed days are high due to high Average Peak Hour Factors of 0.93 and 0.94 respectively for morning and evening. Findings from the study also revealed that causes of traffic congestion included bad roads, breakdown of vehicles; traffic checks; roadside trading; on-street parking; increased car ownership; irregular bus stops; cultural and religious activities; and accidents. The study recommended that the Federal Road Safety Commission should implement Road Safety Policies to reduce accident and traffic congestion. Government should also redesign road network through the concerted efforts of the Town Planners and Architects to reduce traffic obstruction and congestion for sustainable intra-urban traffic management.

Keywords: *Intra-Urban Traffic Issues; Road Design; Existing Infrastructure; Enugu Metropolis*

Introduction

It is widely believed that urban transport system plays a crucial role in the growth and development of cities all over the world. As pointed out by Levkovich, Rouwendal and Van Ommeren (2020) transport infrastructure expansion has stimulated urban growth and land use change. It is however rather unfortunate that from all indications, many transport systems are beginning to threaten the very livability of the cities they serve owing to traffic congestion. According to Afolabi and Gbadamosi (2017), the significance of public transport in many developing countries lies in the fundamental fact that mobility and accessibility are essential for economic growth and of necessity to provide efficient and effective movement for goods and services. *Sam and Carey (2020) stated that* transport creates the utility of an area through the movement of goods from the place of production to the place of consumption. The United Nations prediction that cities with one million people will increase to over 300 by the year 2000 in the developing world gives credence to this fact. This trend is likely to continue due to rapid urbanization, assisted by improvements in health care and the multifarious functions performed by cities which form a major attractive force. This situation has its impacts on the movement of people most especially in the developing world. Thus, these activities make them generators and attractors of traffic, which of course has implications on mobility Ogunbodebe (2016).

Traffic flow can be divided into Uninterrupted flow and Interrupted flow. Uninterrupted flow is a type of flow regulated by vehicle-vehicle interaction and interaction between vehicle and the roadway. Vehicle traveling on inter-state highway participate in uninterrupted flow. Contrary to this, there exist interruptions in traffic flow on our inter-state highways. Interrupted flow is a type of flow, which is regulated by an external means such as traffic signals. Under interrupted flow conditions, vehicle-vehicle interactions play a secondary role in defining the traffic flow (Alber (2015).

Traffic congestion regarded as a global phenomenon is associated with urban environment across the globe; this is due to the fact that people need to move from one place to the other, especially when trekking becomes inefficient. A forecast by Global Traffic Volume (GTV) reveals that traffic congestion would double between 1990 and 2020 and again by 2050 (Engwitch, 2014).

Another forecast by International Road Index on congestion and mobility trends for over 200 cities across 38 countries reveal that over half of these cities registered over 100 hours lost in congestion per driver per year. A recent survey revealed that average commuting time is more than I hour each week day per workers in 41 out of 52 countries. This assertion as envisaged by the end of year 2020 and 2050 is an indication of what the future congestion portends for people living in urban environment (Ogunbodede, 2016). In view of the above, The aim of this study is to evaluate the Intra-Urban Traffic challenges in relation to the road design and existing infrastructure in Enugu Metropolis, Enugu State, Nigeria with the objectives of assessing the level of traffic congestion at the peak hours in the study area; evaluating the condition of the existing transport infrastructure and facilities owing in relation to road designs in the study area; and ascertaining the causes and characteristics of vehicular traffic composition of selected roads in Enugu metropolis.

Literature Review

This section reviews transport as an instrument of urban development and functioning in different parts of the globe. Transport has been described as the basis of how cities work. Urban centres worldwide are perceived as centres of excellence, and centres of opportunities where aspirations and desires are met. Unlike in the more developed countries of Europe and America, where a strong correlation exists between the rate of urbanization and most indicators of development, the situation in African in general and Nigeria in particular is a different scenario (Ikya, 1993; Solanke, 2013; Ademiluyi and Solanke 2008). China is one of the largest countries of the world and it has experienced an unprecedented population change which had resulted in authorities developing new transportation modes as current transport systems have become inadequate in meeting the mobility needs of its population (Wang and Chen, 2018).

The city of today is very complex. It is made up of living, functioning and interacting parts. It covers large expanse of land and accommodates varied activities. In order to allow the necessary functional inter-relationships among the different land uses in urban areas, cities are served with transport facilities. Transport systems are the veins and arteries of urban areas; linking together social areas and functional zones. Intra-urban transportation in particular functions to integrate various parts of the city: work, school, and recreation into a unified whole.

Urban Transport Situation

Urban transportation physically takes place on land, waterways and in the air. The movement on land is characterized by private automobiles, walking, bicycles, motorcycles, tricycles, buses and coaches. The rail system comprises of surface rail, tram, metro lines, subways and underground. The inland waterways are made up of the lagoons, creeks, ports and sometimes the lakes on which both ferries and hovercrafts are the major vehicles for mobility within the cities (Solanke, 2013). According to Hamid, Sandblom and Li, (2021), the recent global innovation due to the Industrial Revolution has brought a lot of advancement in transport technologies and these innovations are said to form future mobility.

Intra-Urban Mobility Pattern in Nigeria

Intra-urban transport is an integral element vital for socio-economic development in any rapidly developing city. Oyesiku and Odufuwa (2014) averred that the situation of mobility in Nigeria is disheartening considering the fact that road movements accounts for about 90 percent of the movement of passengers and freight. Usually, the provision of intra city public transport is considered to be government's responsibility however, due to resources and weak management capacity government-provided intra city transport is inadequate and dysfunctional. Informal public transit services owned and managed by private individuals or establishment have dominated the transport sector and exploiting the poor masses with higher fare rates. According to Kuma, Samba and Kimengs (2020), the inadequate transport infrastructure is conspicuous in Cameroonian and Nigerian cities owing to the effects of sudden increase in travel demand due to the overall population growth and increasing urbanization.

Study Area

Enugu metropolis lies approximately between latitude $6^0$21' N and $6^0$30'N and between longitude $7^0$26' E and $7^0$37'E of the Greenwich Meridan. The total area coverage is approximately 72.8 square kilometers. Enugu Metropolis comprises three council areas: Enugu North, Enugu East and Enugu South Local Government Areas. It is bounded in the East by Nkanu LGA, in the West by Udi LGA, in the North by Igbo-Etiti and Isi Uzor and in the South by Nkanu West LGA. Figure 1 is the map of Enugu State showing the study area (Archibong, 2006).

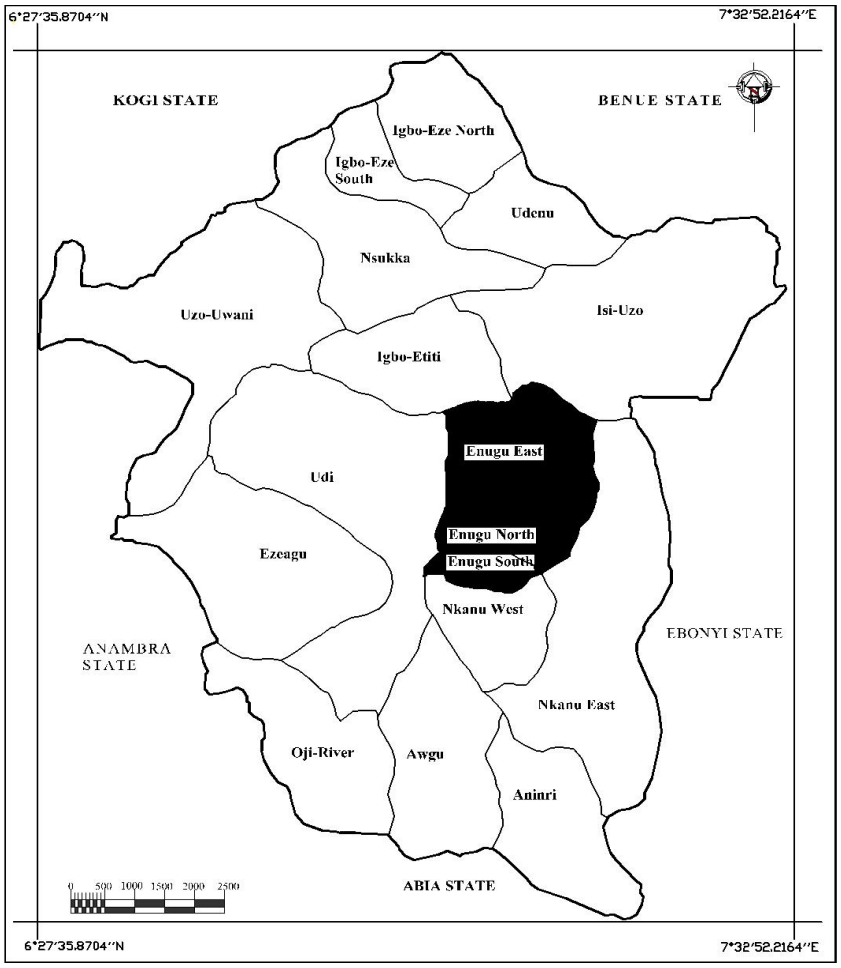

Figure 1: Map of Enugu State
Source: Enugu State Geology and Survey, 2022

Research Methodology

This section deals with the research methods adopted in achieving study aim and objectives. The Research Design employed a cross-sectional survey design aimed at evaluating the intra-urban traffic problems in Enugu metropolis, Enugu State, Nigeria. The data for objectives which are assessing the level of traffic congestion at the peak hours in the study area; evaluating the condition of the existing transport infrastructure and facilities in the study area; and ascertaining the causes and characteristics of vehicular traffic composition of selected roads in Enugu metropolis were collected through questionnaire, interview sessions, manual traffic count, personal observation and Enugu State Ministry of Transport. Traffic situation and Vehicular Composition in Enugu Metropolis were analyzed with reference Holy Ghost/Ogbete Route as the route is the busiest route in Enugu metropolis at all times compared to other routes. In order to effectively determine the level of traffic situation and vehicular composition along the identified route, a manual traffic count was carried out for a period of five (5) days (Tuesday to Saturday) (See Tables 1. 2, 3, 4 and 5). Thereafter, the Peak Hour Factors were determined. Three points which experiences high vehicular movements were determined along the route and traffic counts were carried out.

Results and Discussion

The data for the 3 objectives were presented in Tables and the results were analyzed. Table 1 to Table 5 present Objective 1: Assessing the level of traffic congestion at peak hours.

Table 1: Traffic count along Holy Ghost axis (Day 1)

Morning 7:00am to 9:00am		**Evening 4:00pm to 6:00pm**	
Period	**Count**	**Period**	**Count**
7:00-7:15am	98	4:00-4:15pm	113
7:16-7:30am	98	4:16-4:30pm	158
7:31-7:45am	106	4:31-4:45pm	287
7:46-8:00am	380	4:46-5:00pm	424
8:01-8:15am	479	5:01-5:15pm	480
8:16-8:30am	604	5:16-5:30pm	560
8:31-8:45am	678	5:31-5:45pm	795
8:46-9:00am	725	5:46-6:00pm	1200
Total	**3168**	**Total**	**4017**

Source: Researchers' Survey (2022)

According to Bassan (2013), the PHF is computed by the following equation:

PHF = V/(4*Vm15) (1)

V: hourly volume (vehicle/hour)

Vm15: maximum 15 minute volume within the hour (vehicle/15minutes)

PHF: Peak Hour Factor

Peak Hour Factor for Morning **= Peak Hour Volume/(4 x highest 15-minutes volume)**
= 3168/(4x725)
= 3168/2900
= 1.09

Peak Hour Factor for Evening **= Peak Hour Volume/(4 x highest 15-minutes volume)**
= 4017/(4x1200)
= 4017/4800
= 0.84

Table 2: Traffic count along Holy Ghost axis (Day 2)

Morning 7:00am to 9:00am		**Evening 4:00pm to 6:00pm**	
Period	**Count**	**Period**	**Count**
7:00-7:15am	82	4:00-4:15pm	205
7:16-7:30am	92	4:16-4:30pm	238
7:31-7:45am	126	4:31-4:45pm	307
7:46-8:00am	280	4:46-5:00pm	497
8:01-8:15am	425	5:01-5:15pm	680
8:16-8:30am	656	5:16-5:30pm	767
8:31-8:45am	778	5:31-5:45pm	867
8:46-9:00am	870	5:46-6:00pm	1378
Total	**3309**	**Total**	**4939**

Source: Researcher's Survey (2022)

Peak Hour Factor for Morning **= Peak Hour Volume/ (4 x highest 15-minutes volume)**
= 3309/(4x870)
= 3309/3480
= 0.95

Peak Hour Factor for Evening **= Peak Hour Volume/ (4 x highest 15-minutes volume)**
= 4939/(4x1378)
= 4939/5512

= 0.90

Table 3: Traffic count along Holy Ghost axis (Day 3)

Morning 7:00am to 9:00am		**Evening 4:00pm to 6:00pm**	
Period	**Count**	**Period**	**Count**
7:00-7:15am	75	4:00-4:15pm	326
7:16-7:30am	99	4:16-4:30pm	333
7:31-7:45am	146	4:31-4:45pm	398
7:46-8:00am	320	4:46-5:00pm	597
8:01-8:15am	405	5:01-5:15pm	675
8:16-8:30am	598	5:16-5:30pm	794
8:31-8:45am	718	5:31-5:45pm	967
8:46-9:00am	820	5:46-6:00pm	1278
Total	**3181**	**Total**	**5368**

Source: Researchers' Survey (2022)

Peak Hour Factor for Morning **= Peak Hour Volume/(4 x highest 15-minutes volume)**
= 3181/(4x820)
= 3181/3280 = 0.97

Peak Hour Factor for Evening **= Peak Hour Volume/(4 x highest 15-minutes volume)**
= 5368/(4x1278)
= 5368/5112 = 1.05

Table 4: Traffic count along Holy Ghost axis (Day 4)

Morning 7:00am to 9:00am		**Evening 4:00pm to 6:00pm**	
Period	**Count**	**Period**	**Count**
7:00-7:15am	52	4:00-4:15pm	297
7:16-7:30am	63	4:16-4:30pm	379
7:31-7:45am	126	4:31-4:45pm	423
7:46-8:00am	292	4:46-5:00pm	497
8:01-8:15am	325	5:01-5:15pm	578
8:16-8:30am	498	5:16-5:30pm	734
8:31-8:45am	679	5:31-5:45pm	892
8:46-9:00am	946	5:46-6:00pm	1279
Total	**2981**	**Total**	**5079**

Source: Researchers' Survey (2022)

Peak Hour Factor for Morning **= Peak Hour Volume/(4 x highest 15-minutes volume)**
= 2981/(4x946)
= 2981/3784 = 0.79

Peak Hour Factor for Evening **= Peak Hour Volume/(4 x highest 15-minutes volume)**
= 5079/4x1279
= 5079/5116 = 0.99

Table 5: Traffic count along Holy Ghost axis (Day 5)

Morning 7:00am to 9:00am		**Evening 4:00pm to 6:00pm**	
Period	**Count**	**Period**	**Count**
7:00-7:15am	41	4:00-4:15pm	296
7:16-7:30am	52	4:16-4:30pm	437
7:31-7:45am	67	4:31-4:45pm	498
7:46-8:00am	98	4:46-5:00pm	564
8:01-8:15am	116	5:01-5:15pm	598
8:16-8:30am	213	5:16-5:30pm	634
8:31-8:45am	276	5:31-5:45pm	846

8:46-9:00am	369	5:46-6:00pm	1423
Total	**1232**	**Total**	**5296**

Source: Researchers' Survey (2022)

Peak Hour Factor for Morning = Peak Hour Volume/(4 x highest 15-minutes volume)
= 1232/(4x369)
= 1232/1476 = 0.8

Peak Hour Factor for Evening = Peak Hour Volume/ (4 x highest 15-minutes volume)
= 5296/4x1423
= 5296/5692 = 0.93

Average Peak Hour Factor for Morning = ∑Peak Hour Volume/∑4xhighest 15 minutes volume
=13871/14920 = 0.93

Average Peak Hour Factor for Evening = ∑Peak Hour Volume/∑4xhighest 15 minutes volume
=24699/26232 = 0.94

From the results obtained, it shows that the level of traffic along Ogbete/Holy Ghost axis, Enugu for the observed days is very high due to high Average Peak Hour Factors of 0.93 and 0.94 respectively for morning and evening. Table 6 presents Objective 2: Evaluating the conditions of the Existing Transport Infrastructure and Facilities in Enugu Metropolis.

Table 6: Evaluating the conditions of the Existing Transport Infrastructure and Facilities in Enugu Metropolis

S/N	Infrastructure	Good 3	Fair 2	Poor 1	Non-existent	Mean X	Remark
1	Road pavement	94	182	98	-	1.7	Fair
2	Bus shed	50	93	201	31	1.4	Poor
3	Traffic light	42	73	235	24	1.4	Poor
4	Buses, cabs.	48	103	173	-	1.8	Fair
5	Parks, bus stops	25	62	243	44	1.2	Poor

Source: Researchers' Survey (2022)

Table 6 revealed the condition of existing transport infrastructure and facilities in Enugu Metropolis. The result showed that road pavement and buses/cabs/taxis were in fair condition while bus shed, traffic light and parks/bus stops were in poor condition. From the personal observation carried out, it was also discovered that most of the transport infrastructure and facilities needed urgent repairs, rehabilitation, expansion and reconstruction. Table 7 presents Objective 3: Ascertaining the causes of vehicular traffic congestion in the study area

Table 7: Response on the causes of traffic in Enugu Metropolis

Option	Frequency	Percentage
Bad road/pot holes	207	79
Breakdown of vehicles	272	73
Traffic check/wardens	268	72
Roadside trading/hawking	328	88
On-street parking	346	93
Increased car ownership	242	65
Irregular bus stops	263	70
Cultural/religious activities	198	53
Accidents	273	73
Flooding	223	60
Absence of traffic lights	307	82
Construction activities	287	77
Improper land use	237	63
VIP movement	187	50
Poor travel information	192	52

Traffic law violation	248	66
Others (specify)	-	-

Source: Researchers' Survey (2022)

From Table 7, it was revealed that all identified causes were responsible for traffic in the study area. The result showed that 79% of respondents indicated bad road/pot holes; 73% indicated breakdown of vehicles; 72% indicated traffic checks/wardens; 88% indicated roadside trading/hawking; 93% indicated on0street parking; 65% indicated increased car ownership; 70% indicated irregular bus stops; 53% indicated cultural/religious activities; 73% indicated accidents; 60% indicated flooding; 80% indicated absence of traffic lights; 77% indicated construction activities; 63% indicated improper land use; 50% indicated VIP movements; and 52% indicated poor travel information and 66% indicated traffic law violation.

Conclusion and Recommendation

It is established that rapid population growth and horizontal motion of cities widen the dimensions of transport problems in urban areas; although each city/town has its own specific transport problems. The Lasting solutions to intra-urban transport problems require a combined efforts Government, masses and policy makers for sustainable intra-urban transport systems. The Federal Road Safety Commission should implement Road Safety Policies to reduce accident and traffic congestion. Government should also redesign road network through the concerted efforts of the Town Planners and Architects for sustainable intra-urban transport system.

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