

# Pattern of Transportation and Its Environmental Impacts in Ekwulobia, South-East, Nigeria

Ezeomede Innocent Chukwukalo<sup>1</sup> Chidubem Onuah<sup>2</sup>

Department of Environmental Management,

Chukwuemeka Odumegwu Ojukwu University, Uli-Campus, Anambra State, Nigeria.

<sup>1</sup>Corresponding author: [innocent.ezeomede@gmail.com](mailto:innocent.ezeomede@gmail.com), +2348 03844 8862

[onuahchidubem2@gmail.com](mailto:onuahchidubem2@gmail.com), +2348 9035055226.

## Abstract

The research, development and design of intelligent transportation systems worldwide relies on technologies that are able to enhance security and safety, increase efficiency, reduce congestion and promote environmental sustainability. However, mobility and transportation are the engines to economic growth of a country. Unfortunately, this engine also depicts the signs of the times (i.e. congestion, accessibility and road safety problems). This study investigated the environmental impacts of pattern of transportation in Ekwulobia, Aguata Local Government Area, Anambra State. In trying to achieve this, the study identified the pattern of transportation and its environmental impacts on the study area, relationships between the impacts and the major cause of traffic congestion and a viable minimization measures in the area. The mixed methods of data collection for the study include; Field observation, Interview, Questionnaire and Survey method. Data generated through these methods were analyzed using chi-square and presented using Tables, Bar charts, and Descriptive analysis. The result of the study showed that the pattern of transportation in Ekwulobia consist of four major road patterns running from Nanka to Oko axis (NN-NE), from Nnewi to Uga axis (NW-NN), from Oko to Uga axis (NE-SE) amongst others. From the result of the traffic count in five days of the week, motorcycle moves at higher volume of 66,881, public bus 37,251, private cars 34,520, tricycle 8,611 and the least is heavy trucks, which moves at the volume of 6,320. Accordingly, the pattern of transportation in Ekwulobia has led to traffic congestion, nucleated structures, noise pollution from car-engines, air pollution from exhausts. Recommendations of the study include: widening of the roads by the Government to reduce traffic congestion, placing of traffic lights to regulate vehicular movement and Urban and Regional planners should help to stop nucleated structures round the Ekwulobia round-about, among others.

**Keywords:** Transportation Systems, Environmental Impacts, Sustainability, Traffic Congestion.

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## 1. Introduction

Transportation is the movement of people or goods from one location to another (Merriam-Webster Dictionary). Transportation is linked to all aspects of human life, our natural environment, economic prosperity, and social well-being all depend on transportation systems that are safe, clean, efficient, and equitable (Ralph, 2002). Transportation has been described as the basis of how cities work (Ikya, 1993; Solanke, 2005; Ademiluyi and Solanke, 2007). Movement and transportation are the locomotives to economic development of a country, (Marianne, 2006). However in the developing nations, the rapid growth of personalized vehicles and poor infrastructure, road design, and law enforcement has resulted in growing accident rate, (USDOT, 2006) [6].

Metropolitan cities currently have grown to the point that has threatened to suppress the existing transportation system (Ikya, 1993). However, according to Jacob Akindele, Special Advice (Road Administration) to Ogun State Government in his report dated 28th March 2011 observed that Nigeria has the longest network of roads in Africa.

Ekwulobia is the most urbanized area in Aguata L.G.A., and as well expanding rapidly to a population of above five hundred thousand people. The increasing population also increased the use of automobile for the different activities going on in and through the area such as educational, political, social, cultural, regional, economical and industrial. All these depend on its accessibility to achieve maximum success in their sector. As a result, this work was incited into identifying the patterns of transportation, environmental impacts of such patterns, relationships between the patterns and the major cause of congestions in the area, while offering possible control measures. It is now widely recognized that society over-reliance on the automobile contributes to environmental problems, especially in urban areas. As a result, transportation research is increasingly focused on understanding the decision-making process of travel behavior changes including mode choice and automobile ownership, (Julia, 2007).

Although transportation is an enormous type of environmental degradation worldwide, but transportation systems are required to deliver mobility to large, diverse and densely populated areas across multiple modes of transportation. Hence, there is need for the research, development and design of intelligent transportation

systems that are able to enhance security and safety, increase efficiency, reduce congestion and promote environmental sustainability. The research will be of great importance in educating the students, the general public, professional bodies as well as individuals. It can be applied in decision making and planning in order to improve the mode of transportation of people, goods and services in Ekwulobia.

This research was completed in 2015 and study aims at assessing the patterns of transportation and its environmental impacts in Ekwulobia, Anambra State. In trying to achieve this, the pattern of transportation was identified, its environmental impacts studied, relationships between the impacts and the major cause of traffic congestion evaluated and a viable minimization measures in the area suggested.

## 2. Review of Literature

Steward, 1998, Ralph, (2002), researched on the concept of sustainable transportation to the USDOT through the Reauthorization of TEA-21, showing that there is growing international agreement on the concept of sustainable transportation and that progress can be made towards a more sustainable transportation sector. According to Palph all transport modes consumes energy and the most common source of energy is the burning of fossil fuels like coal, petrol, diesel etc. one of the most serious forms of pollution is the contamination of the air by various particles and gases. Jean and Paul, (2013), researched on the environmental impact of transportation on soil and noted that soil is usually contamination in the process. Moreover, the impact of road transportation on Biodiversity was researched by Jean and Paul, (2013) and they noted that transportation impacts natural vegetation through deforestation.

Amba and Danladi, (2013) appraised the Nigerian Transport sector where the result shows indices of a incessant fall in the activity of transport sector in Nigeria, thereby detecting high operational cost and insufficient funding as major challenges threatening the sub-sectors. Adetunji, (2013), investigated the quality of transport services in Nigeria using Ibadan metropolis as case study, and result showed that poor service delivery of transport system has created impairments towards the smooth movement of people, goods and services in some other urban centres in Nigeria. While, according to Ikegbunam, (2017), investigated the Onitsha urban road transport system implications for urban transport planning. The results show positive correlation between traffic congestion and hourly flow of traffic for seven roads; and a negative correlation for three roads. Environmental problems arising from urban road transportation in Onitsha were evaluated with policy implications.

## 3. Theoretical/Conceptual Framework

This study evolves from graph theory, and central place model, graph theoretical analysis by Kansky (1963). This model has turned out to be an appropriate method for understanding, representing and manipulating spatial structures. Several indices like the Beta ( $\beta$ ), Gamma ( $\gamma$ ), and Alpha ( $\alpha$ ), combined in the model have been used to measure road work connectivity (Garrison and Marble, 1962). The analysts of such road network in various countries have revealed a strong correlation between levels of economic development in those countries and topological connectivity indices (Kansky, 1963). The accessibility of a place is simply the degree of connection between the place and all other places in transport network because the main conception in this case is the ability to get to a given node, the connection component of the road. This agree with the binary accessibility matrix introduced into graph theory by Garrison (1960) and has before now formed the basis for measuring the connection component of the road network in given local area and its applications.

## 4. Materials/Method

Ekwulobia is a town in Aguata Local Government Area of Anambra State of Nigeria, Figure 1, 2 and 3 respectively. It lies between latitude  $06^{\circ} 01' 48''$  N to  $06^{\circ} 03' 00''$ N and longitude  $07^{\circ} 01' 36''$  E to  $07^{\circ} 05' 24''$  E, it is bounded on the North by Nanka, on the south by Oko and on the West by Isuofia. It comprises of nine villages divided into two notably Ezi and Ifite. The villages in Ezi are Umuchiana, Umuchi, Okpo, Nkono, Abogwume and Ihuokpala while Ifite are Agba, Ula and Eziagulu.

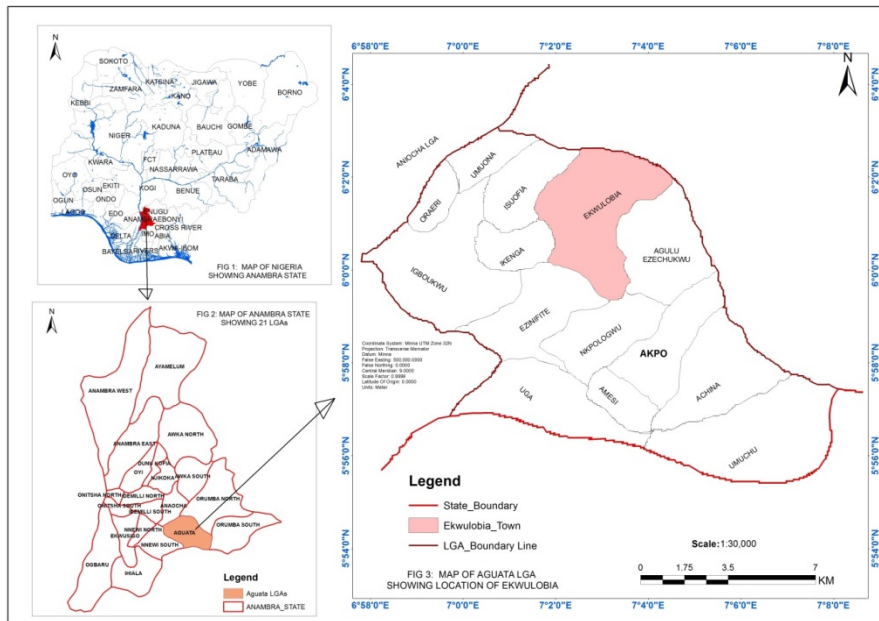


Figure 1: Location of Ekwulobia town in Aguata Local Government Area of Anambra State of Nigeria



Figure 2: Google earth Satellite image showing Ekwulobia road network  
 Source: Google earth Image

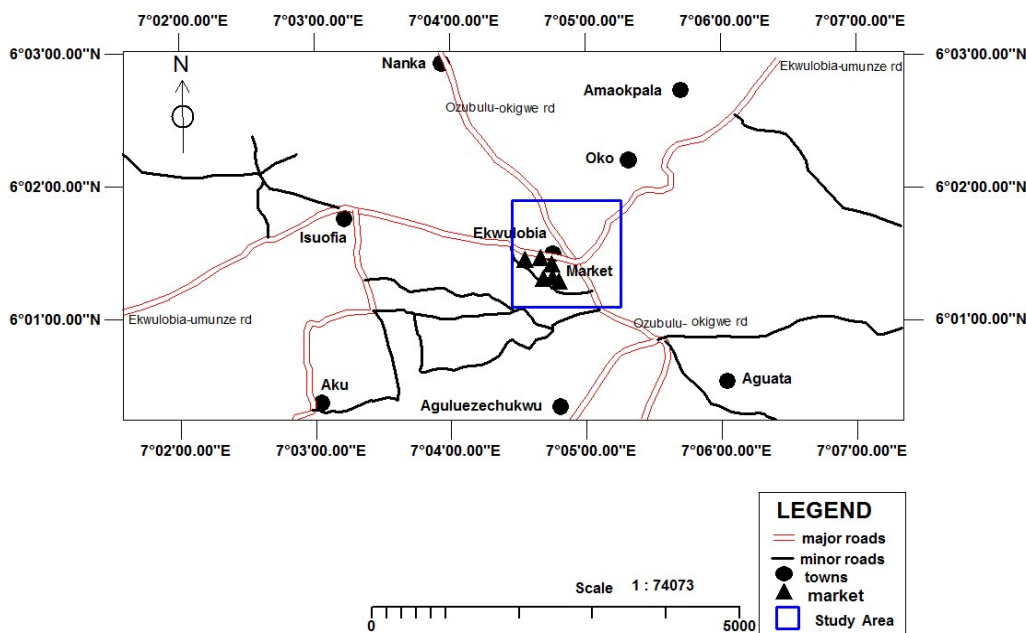


Figure 3: Major road networks of Ekwulobia

The study area has a rugged relief as it lies partly on the Awka-Orlu upland and the flood plain of Mamu river, which is an area of moderate relief (Ofomata, 1975). Geologically, the study area is overlaid by Agulu-Nanka formation, made up of highly sediments of friable sandstones, shales and limestone. They are mainly of cretaceous periods. The sandstones which mainly dominated the area, is susceptible to erosion, which is typified by the nearby and infamous Agulu-Nanka gully sites (Ofomata, 1985). The area has much of surface drainage systems through which the excess water is removed from the land. The components of the drainage system form the tributaries of Mamu and Anambra rivers which empty into the River Niger (Ofomata, 1985). The climate according to Koppen’s climatic classification, is tropical Wet and Dry climate (Aw). The rainfall is controlled by the position of Inter-Tropical Divergence, which is experienced for 8 months of the year from April to November with July and September as the months of highest rainfall of about 350mm (Ogbukagu, 1976, Anyadike, 2002). The vegetation lies within the humid tropical rainforest region of Nigeria.

According to 2006 National population census, the population of Ekwulobia is 55,000 using this figure the population of the study area has been projected to 69,080 in 2014. The inhabitants indulge in farming, wine tapping, palm oil extraction, trading, small scale industries such as welding, carpentry, shoe making, motor, motorcycle and bicycle repairing, television repairing, watch repairing, painting etc. as a means of livelihood. Also in the area are hotels, supermarkets, restaurants, patent medicine stores, all centre around the major market (Eke market) near the Ekwulobia traffic network. It has a good number of schools (primary and secondary), banks and hospitals, transit parks from where travelers can connect to other far cities in Nigeria, a stadium, hotels, student’s hostels, a federal prison and several new agro-based factories which attract people into the town.

#### 4.1. Data Used

The data used for this study is of two types; primary and secondary data source. These include all the data collected through field observation, use of questionnaire and oral interviews Geographic information system, interviews, grounded theory approach, stratified random sampling techniques, measurement, and survey method, information sourced from published text books, journals, conference papers, articles, internet materials and unpublished projects. For reliable and quality result in this study, survey and description research designs were adopted. The survey design involves personal observation, use of questionnaire personal interviews and traffic count. Traffic count was conducted at Ekwulobia round about which connects four major roads in Ekwulobia. The roads are Ekwulobia-Uga road, Ekwulobia-Oko road, Ekwulobia-Nanka road, Ekwulobia-Nnewi road and traffic count was conducted on the four roads for one week from morning (6.00am-10.00am), between late morning and midday (10.00am-12.00pm) to evening (12.00pm-6.00pm) each day of the week.

Sample frame and preliminary field survey were carried out to determine the number of households in Ekwulobia while getting conversant with the study area. The population of the study area is given to be 55,000 (NPC 2006) and is projected to 70,840 in 2015. The acceptable average household’s size in urban area of Anambra State is calculated to be 4.6 that is approximately 5 (National Population Commission Awka).

Traders, drivers and trip makers in Ekwulobia were interviewed for more information on the impacts of the

pattern of transportation on their environment. However, use of open ended and closed ended questionnaire was involved for people’s demographic information. The questionnaires contained (38) thirty eight questions. A total of 68 questionnaires distributed out of which 52 questionnaires were returned. The questionnaires were administered to drivers, traffic wardens, traders and pedestrians on the locations.

#### 4.2. Data Analysis

The Statistical Package for Social Sciences (SPSS), computer software designed for statistical computations was employed for the data analysis, where the Chi-square test was used for analyzing the data obtained on pattern of transportation and its impacts on the environment. Chi-square test shows the level of agreement of the result of the responses from the respondents. The chi-square test ( $\chi^2$ ) is used to test the null hypothesis. The  $\chi^2$  was used to compare actual observed distribution with a hypothesis or expected distribution. The chi-square, test, the level of agreement of the responses with 0.05 level of significant and compared with the 0.10 level of significance.

The data were used to answer the research questions on frequency tables, percentages and charts. Also, the hypothesis was tested using the Chi-Square test. The decision rule is: reject the  $H_0$  if the computed p. value (significant value) is less than the test probability (0.05); alternatively, when p. value is greater than 0.05, we should not reject the null.

#### 4.3. Result Presentation and Discussion

Result of traffic count along Nnewi-Ekwulobia route into Ekwulobia-Uga road (axis) morning (6.00am-10.00am)

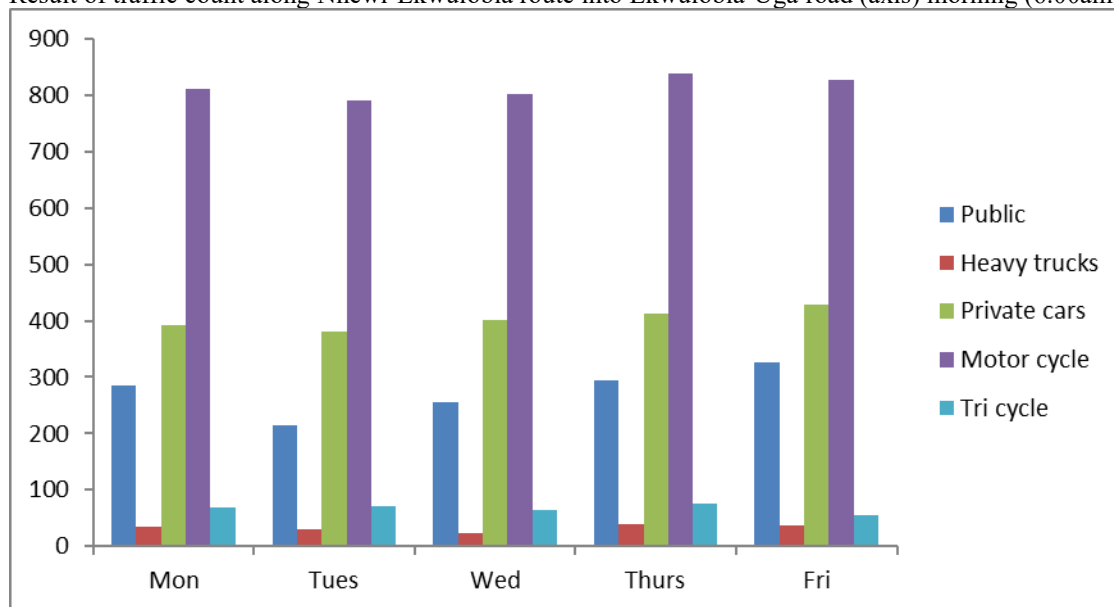


Figure 4: Bar chart showing average number of vehicles at the roads in the morning

From figure 4 above, the volume of motorcycle is highest all through the week, being that people make use of motorcycle more than vehicles due to easy movement. Heavy trucks are the lowest among all. Private cars and public buses are closely related in numbers due to economic activities that attracts traders, workers and buyers. The volume of vehicle out from the road is not as high as Uga-Ekwulobia road that has banks, Ekwulobia market and parks along the road side. Sometimes, there is slow down caused by vehicles entering Ekwulobia-Uga road due to bad road (pot holes), park at the both side of the road and population of people moving to and fro. These attributes to the traffic congestion on this roads, but Nnewi-Ekwulobia road has less activity that could increase the volume of vehicle. In the evening, the volume of vehicles are higher when every activity of the day comes to an end whereby people are going home, travelers are travelling leading to congestion because the road contains large volume than it should carry.

Result of traffic count along Uga-Ekwulobia road into Ekwulobia-Okoro road (axis) in the morning (6.00am-10.00am)

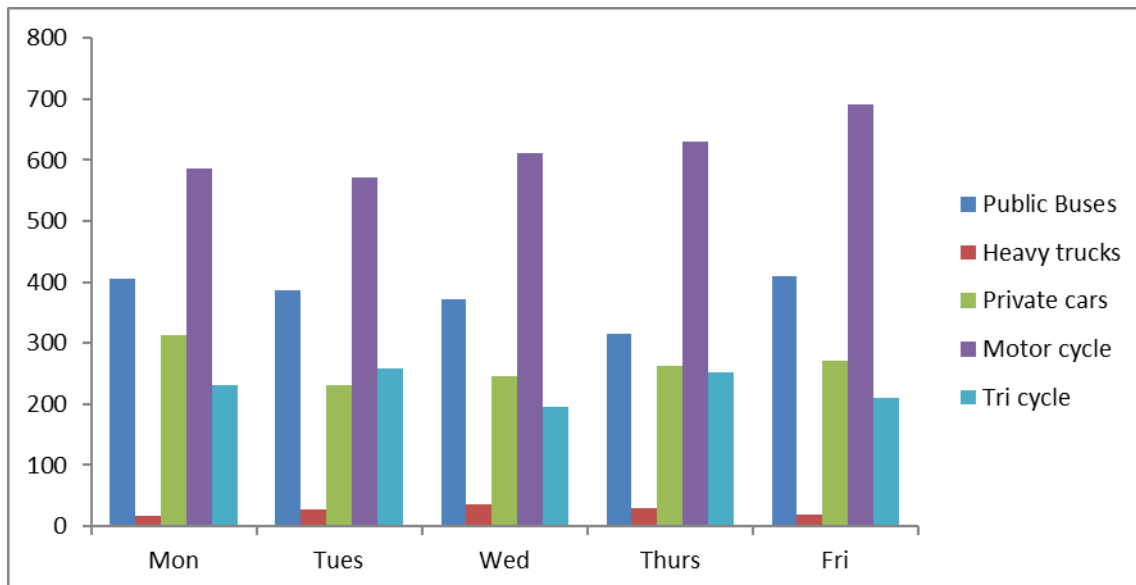


Figure 5: Bar chart showing average number of vehicles at road in the morning, entering Ekwulobia-Oko road

From figure 5 above, the volume of vehicular movement is high but not to compare with other roads, due to students of Oko Federal Polytechnic making use of motorcycle and tricycle is higher. The road is usually busy in the morning. However, there is a decline in volume of vehicles out of Oko-Ekwulobia in the sense that in the morning instead of leaving Oko people mostly move down to Oko to their various work places and to school for students therefore there is low movement of vehicles out of Oko-Ekwulobia. In the afternoon, motorcycle and Tricycle volume is higher indicating their frequent movement on the road. This is as a result of students in Oko Polytechnic that prefer the use of motorcycle and tricycle, following public buses. This road does not usually experience traffic congestion due to frequent use of Tricycle and motorcycle. In the evening, the volume is high, because everyone is going home from work, market etc. The road is busy at this period but mostly motorcycle and Tricycle moving. Although sometime there is little congestion that doesn't last caused by passengers entering vehicles along the road side and vehicles coming out from Ekwulobia Park (table 1).

Table 1: Result of traffic count along Uga-Ekwulobia road into Ekwulobia-Oko road (axis) in the evening (2.00pm-6.00pm).

Type of vehicle	Mon	Tues	Wed	Thurs	Fri
<b>Public Buses</b>	352	366	386	456	472
<b>Heavy trucks</b>	77	72	87	98	92
<b>Private cars</b>	272	298	324	318	333
<b>Motor cycle</b>	709	714	698	731	682
<b>Tri cycle</b>	214	209	196	232	242

Result of traffic count along Nanka-Ekwulobia road into Ekwulobia-Nnewi road (axis) in the morning (6.00am-10.00am)

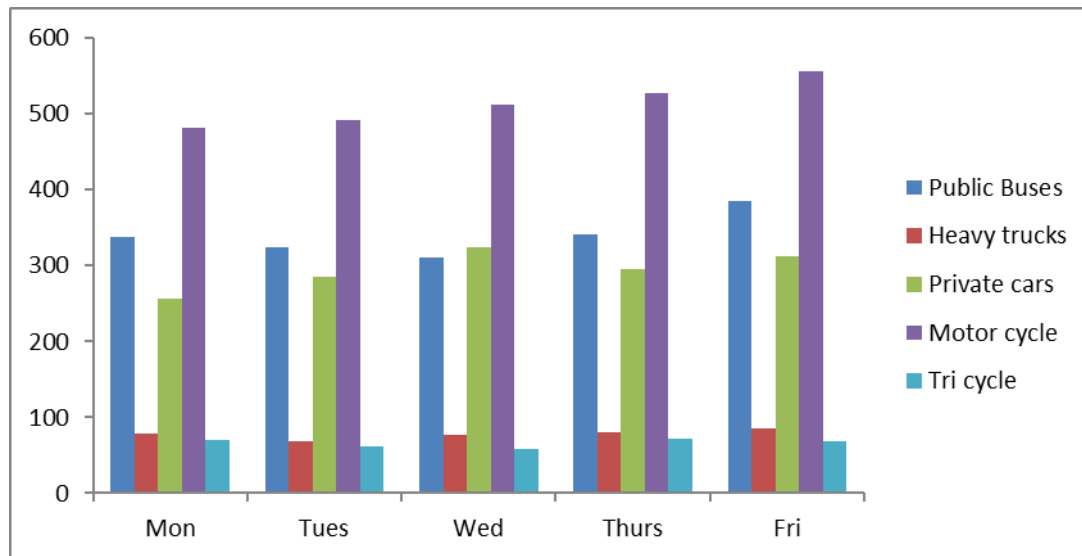


Figure 6: Bar chart showing average number of vehicles on Nanka-Ekwulobia road into Ekwulobia-Nnewi road. From figure 6, the volume of vehicle is moderate, heavy trucks moves in at moderate rate due to building material shops along the road. Sometimes traffic congestion is been experienced on this road caused by packed heavy trucks like trailer along the road. Also, presence of filling station at the two sides of the road facing each other which causes slower movement of vehicle. But in the evening, the volume tends to increase because it is the period whereby roads are busy caused by people going home from their day activities, plate 1.



Plate 1: Traffic congestion in Ekwulobia roundabout

Table 2: Result of traffic count along Oko-Ekwulobia road into Ekwulobia-Nanka road (axis) in the morning (6.00am-10.00am)

Type of vehicle	Mon	Tues	Wed	Thurs	Fri
<b>Public Buses</b>	324	298	319	347	367
<b>Heavy trucks</b>	18	12	9	13	10
<b>Private cars</b>	278	314	298	322	320
<b>Motor cycle</b>	311	287	299	332	342
<b>Tri cycle</b>	19	12	10	14	11

The movement of motorcycle is high followed by public buses, then private cars follows. Traffic congestion is been experienced during this period due to heavy trucks parked along the road side by the building materials sellers causing vehicles to move at slow speed to avoid accident and also vehicles coming out from filling stations, people likely refill their tanks when going home in the evening, so all these activities delay vehicular movement.

From table 2, the volume of Public Buses and private cars are on the increase. This shows that, in the

morning vehicles that go to Nanka, Agulu and Awka are usually vehicles on the road. In the afternoon, the volume reduces, because most vehicles that move at this road are public buses that carry passengers from Ekwulobia to Awka, then Tracas(Transport Company of Anambra State) and Ekwulobia Urban Mass Transit.

In the evening whereby everyone is going home from various work places, the road experiences congestion due to slow down from Uga-Ekwulobia road which linked to Ekwulobia-Oko road, Ekwulobia-Nnewi road and connects also to Ekwulobia Nanka road. Most times, traffic congestion is mostly caused from Uga-Ekwulobia road due to bad road and nucleated structure along the road, figure 7.

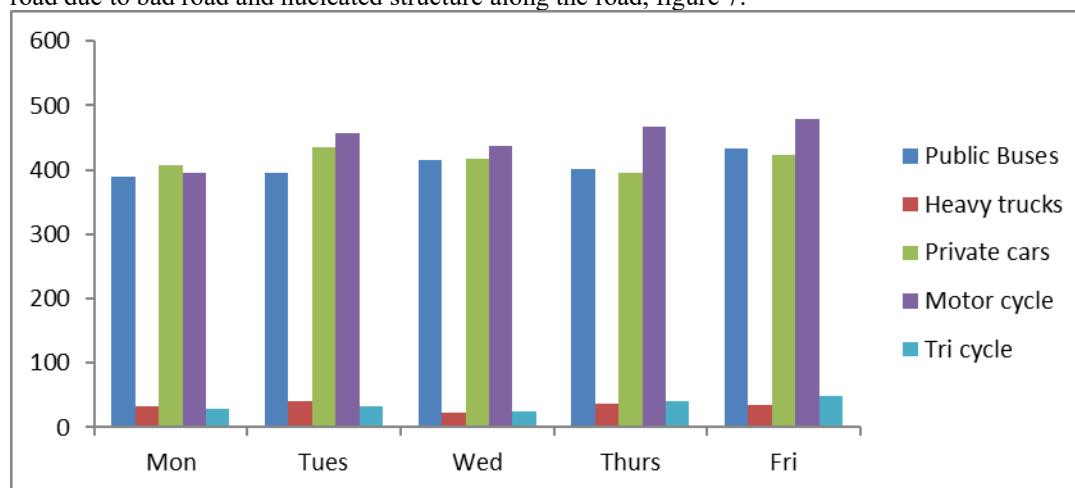


Figure 7: Average number of vehicle leaving Nanka-Ekwulobia road in the evening

Table 3: Age structure of respondents in Ekwulobia

Age	Respondents frequency	Percentage
10-15	0	0
16-20	2	3.85
21-25	6	11.54
26-30	15	28.85
31 and above	29	55.77
<b>Total</b>	<b>52</b>	<b>100</b>

From table 3, the result shows the majority of respondents are within the age bracket of 31-35 and above. This shows that greater portion of the respondents are adults with adequate knowledge of the study area and thus, the level of accuracy of the information which they gave the researcher is high.

Table 4: Respondents observation on environmental impacts of pattern of transportation in Ekwulobia

Road	Respondents	Air pollution		Noise pollution		Loss of biodiversity		Soil quality degradation	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%
Ekwulobia-Uga road	Agreed	14	26.92	15	28.85	9	17.31	6	11.54
	Disagreed	2	3.85	1	1.92	7	13.46	10	19.20
Ekwulobia-Oko road	Agreed	10	19.23	12	23.1	9	17.31	5	9.64
	Disagreed	4	7.69	2	3.85	5	9.64	9	17.31
Ekwulobia-Nanka road	Agreed	10	19.23	11	21.15	8	15.38	4	7.69
	Disagreed	3	5.77	2	3.85	5	9.64	9	17.31
Ekwulobia-Nnewi road	Agreed	8	15.38	9	17.31	4	7.69	2	3.85
	Disagreed	1	1.92	0	0	5	9.64	7	13.46
<b>Total</b>	<b>52</b>	<b>52</b>	<b>100</b>	<b>52</b>	<b>100</b>	<b>52</b>	<b>100</b>	<b>52</b>	<b>100</b>

In table 4, the number of respondents that agreed that pattern of transportation leads to environmental impacts varies greatly to compare with those that disagreed in the four routes of this study. From Ekwulobia-Oko, Out of 16 respondents, 14 agreed that pattern of transportation causes “Air pollution” 15 agreed that it causes “Noise pollution 9 agreed that it causes “Loss of biodiversity and 6 agreed that it causes “soil quality degradation”. For Ekwulobia-Oko road, out of 14 respondents, 10 agreed that it causes “Air pollution” 12 agreed



that it causes “Noise pollution”, 9 agreed that it “Loss of biodiversity”, 5 agreed that it causes soil quality degradation. For Ekwulobia-Nanka road, out of 13 respondents, 10 agreed that pattern of transportation causes “Air pollution”, 11 agreed that it causes “Noise pollution”, 8 agreed that it causes “Loss of biodiversity” 4 agreed that pattern transportation causes “soil quality degradation” For Ekwulobia-Nnewi road, out of 9 respondents, 8 agreed that it causes “Air pollution” 9 agreed that it causes “Noise pollution” , 4 agreed that it causes “Loss of biodiversity, 2 agreed that pattern of transportation causes “Soil quality degradation” With these, we can now observed that pattern of transportation has environmental impacts.

However, using chi-Square, the hypothesis was tested for the significance of the association between Respondents on effect of Pattern of transport and the networks (as proxy for patterns). The variables comprise four (4) effects of patterns and 4 groups of respondents (the respondents on each of the roads). 52 respondents participated in the study (table 5).

Table 5: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.786 <sup>a</sup>	13	.042
Likelihood Ratio	18.869	13	.036
Linear-by-Linear Association	6.482	1	.065
N of Valid Cases	52		

From the result of the analysis: Chi-square value = 28.286, P.value = .042 (p. < 0.05).

From the result Chi-square test, it is shown that Chi-square value is 28286 with a probability value of 0.042. Since the p-value is less than 5%, we reject the null hypothesis that “pattern of transportation has no significant impact on the environment of the study area”, and accept the alternate hypothesis and conclude that pattern of transportation has significant impact on the environment of the study area.

This shows that the way a road network is constructed, whether freeway, dual way, highway etc, would have effect on the environment. According to the study, these effects include air pollution, noise pollution, dusty environment and land degradation among others. The finding implies that residents of communities very near to the major nodal point of the road networks will suffer more negative effect than those in an area where road networks do not pass through.

## 5. Conclusion

This study investigated the pattern of transportation and its environmental impacts in Ekwulobia, Aguata Local Government Area, Anambra State. It was derived that the pattern of transportation in Ekwulobia has led to environmental impacts and health effects of the inhabitants of Ekwulobia and it is as a result of man’s use of vehicles for transportation of goods and services. Thus, there was a strong agreement by the inhabitants of Ekwulobia that pattern of transportation causes environmental effects like; Air pollution by emission of gases to the atmosphere from vehicle exhausts, noise pollution, dust pollution, soil degradation, traffic congestion, loss of lives by accidents.

Although transportation is an enormous type of environmental degradation worldwide, but transportation systems are required to deliver mobility to large, diverse and densely populated areas across multiple modes of transportation. But for the “safe environment” for all, there should be research, development and design of intelligent transportation systems that are able to enhance security and safety, increase efficiency, reduce congestion and promote environmental sustainability.

## 6. Recommendations

A call is made to the government and law enforcement agencies to join hands in combating this environmental problems and implications of transportation pattern in Ekwulobia, by constructing more solid and wide roads to ensure free movement of vehicles and adequately compensate any victim of loss of property caused by such construction.

The Federal and State Government should ensure prompt repairs and maintenance of any damage section of their road (s), to enhance free flow of vehicles. The relevant authorities should prohibit any packing of vehicles along the road side, discourage street trading and regulate development that are very close to the major roads .

Government should ensure that traffic lights are been put in place in the sense that it helps to control speed of vehicles, control the emission of gases from vehicle exhaust especially vehicles with damaged exhaust which emits a lot of smoke (gases) to the atmosphere.

Government should construct “walk-ways” or “Pedestrian Bridge” to save lives, while ensuring that heavy trucks such as tankers that transport petroleum, gas, etc moves in the night or evening to minimize the rate of traffic congestion and accidents.

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