

Environ

JOURNAL OF ENVIRONMENTAL STUDIES

Vol. 5 No. 1 NOVEMBER 2023

ISSN: 1110 - 457X



**FACULTY OF ENVIRONMENTAL DESIGN
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ENVIRON
JOURNAL OF ENVIRONMENTAL STUDIES



Published by
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EDITORIAL

Advancing the frontiers of knowledge and innovation is a prerogative of academic journal publications and this is clearly evident in ENVIRON Journal of Environmental Studies which aims to create an avenue for the dissemination of academic researches which cover the creation of built environments and landscapes that are designed to improve the artistic, natural, socio-cultural and physical quality of life and the natural environment.

ENVIRON is an inter-disciplinary scholarly peer reviewed publication and welcomes original articles exploring wide range of topics in the built environment discipline. This issue of the journal covers interesting and thought-provoking topics in Urban Management of transport systems, urban drainage system, land use, climate studies and building performance in educational institutions. The articles explored challenges and advancements in the field of construction project management, contract management, safety management and risk management. The trends in use of artistic and creative colour choices and materials are also explored with the view to capturing latest trends in the Fine Arts domains.

On behalf of the Editorial Board, I wish to express our profound gratitude to the distinguished academics who have sacrificed their time to review these articles. The Authors who conducted researches and submitted articles for publications have made this issue rich in content and we are most appreciative of your faith and trust in the Journal as a medium for disseminating your researches.

Moving forward, the Journal hopes to publish articles which explore ground-breaking research or projects on the importance of sustainable design/development, emerging technologies such as Industry 4.0/5.0; the application of Data analytics and Artificial Intelligence in the Built Environment, and perhaps touch on Industrial Design (Ceramics, Graphics and Textiles), Innovative Design Thinking and Quantity Surveying.

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Professor Kulomri Jipato Adogbo
Editor-in-Chief

ASSESSMENT OF THE CAUSES AND EFFECT OF TRAFFIC CONGESTION ON ROAD USERS IN MAJOR ROAD INTERSECTION IN MINNA METROPOLIS

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Abstract

Over the years, studies on traffic congestion have been conducted to assess the causes and effects on road users' productivity, and the country's Gross Domestic Product (GDP). This is because traffic congestion restricts commuters' movements and also shapes their lifestyles. This paper examined the cause and effect of traffic congestion on road users at major road intersections in Minna. The study employed both experimental and survey research design to study the traffic congestion around the major road intersections in Minna. Traditional traffic count was conducted by the authors in order to determine vehicular traffic volumes and its composition around the intersection. While at the same time the authors randomly distributed 384 questionnaires to capture the resident perceptions on the possible causes and effect of traffic congestion on the users. The collected data was analysed using descriptive and inferential statistics. The results suggest that there are 15,618 vehicular traffic volumes around the major intersections of roads in Minna, with private vehicles (i.e., 7231 cars) and tricycles (i.e., 4477 tricycles) accounting for the majority of the volumes. The study outcome also reveals among others that the presences of road side market, increased population, and lack of parking lots resulting to on street parking are some of the factors causing traffic congestion in the study area. In addition, some of the effects of traffic congestion identified were time wastage, higher transportation fare and higher fuel consumption. The study concluded that the effects of traffic congestion on road users in Minna were less when one compares it to that of mega cities in Nigeria. The study recommended that the Niger State Government, through her relevant agencies, should prevent unlawful road side commercial activities. They should also enlighten Minna residents about the dangers of establishing markets along the road sides.

Keywords: Causes and Effects, Minna Metropolis, Road Intersections, Road Users, Traffic Congestion

INTRODUCTION

One of the disadvantages of urban road transport is traffic congestion. Congestion occurs when there is an excessive amount of demand for travel, which results in interactions between vehicles that slow down traffic flow and increase tailgating and slower speeds (Olagunju, 2015).

Gabriel (2013) described traffic congestion as a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. Traffic congestion has caused a lot of economic losses in both developed and developing nations. According to the

annual World Economic Forum (WEF, 2018) estimates, the economic loss due to traffic congestion in the United States economy was estimated to be \$87 billion. In another research conducted in Lagos Nigeria by Danne Institute for Research (DIR, 2021), the economic loss of traffic congestion to micro, small and medium sized businesses in Lagos was estimated to be about N4 trillion annually. This is a huge loss to the economy of Lagos state and Nigeria at large.

There are several factors that cause traffic congestion on road transport networks. These include shortage of parking spaces, bad roads, increased population, increased vehicle ownership, poor driving practises, work zones, and insufficient road capacity as the factors responsible for traffic congestions (Nushrat & Sanjay, 2018; Rao & Rao, 2012; Raheem *et al.*, 2015; Broadstock, 2011; Pacione, 2005; Bashiru& Waziri, 2008; and Aworemi *et al.*, 2009).

Traffic congestion is severe at major road intersections in Minna. This is manifested in areas such as Mobil roundabout, Obasanjo roundabout, City Gate roundabout, Kpakungu roundabout, and DutsenKuragwari junction. Despite the government's efforts to reduce traffic congestion in these road intersections, the effort is yet to achieve the desired results as congestion still persists around major road intersections in Minna. It's against this background that this foregoing study seeks to examine the factors causing traffic congestion in Minna metropolis as well as the effect on road users in the state capital with a view to addressing the challenges.

LITERATURE REVIEW

Theoretical Review

There are so many theories put forward by researchers in the past to explain traffic congestion. The most common of the theories is the macroscopic traffic flow model. The theory was first introduced by Lighthill & Whitham (1955). The theory is a mathematical representation of the interactions between several aspects of traffic flow, including density flow, and mean speed of a stream of traffic. According to the idea, traffic streams are equal to fluid streams as a whole; thus, the approach of simulating traffic flow at the macroscopic level was created. Another theory that explains the concept of traffic congestion is the Three- phase traffic theory. The theory was created by Kerner Boris in 1996. The theory explains the physics of traffic breakdown and the ensuing clogged highway traffic. The three-phase traffic theory categorises congestion into two types: synchronised flow and wide moving gridlock. After the congestion transition, unconstrained flow becomes synchronised flow. Although the speed of the vehicles dramatically decreases in the synchronised flow, there is no discernible change in the flow rate. The synchronised flow will cause the wide moving jam to develop spontaneously.

The system theory is another theory which has gain significance in the study of traffic congestion in the past. The system theory was introduced by Bertalanffy (1950). Systems theory is the study of systems. Systems are coherent groups of linked, interdependent components that can be produced either naturally or artificially. Every system has causal boundaries, is affected by its environment, is defined by its structure, function, and role, and interacts with other systems via these connections. In system theory it believed that changes to

one system component may have an impact on other system components or the entire system. For instance, change in transport demand results to change in transport supply. However, an increased demand without corresponding expansion in transport infrastructure will result to congestion on the infrastructure.

Simple Causes of Traffic Congestion

The factors causing traffic congestion has been categorized by researchers, according to Nushrat & Sanjay (2018) divided the causes of traffic congestion into the public, operator, and expert points of view groups in their study. In contrast, Rao & Rao (2012) divide the factors that contribute to traffic congestion into micro and macro factors. The high level of traffic in cities is caused by an increase in private car ownership and the resulting growth in the number of private vehicles. Since most activities, including employment and business prospects, are concentrated in metropolitan areas due to social economic growth, there is an increase in demand for transport services in these locations (Alam & Ahmed, 2013). Poor land use planning has also been linked to the causes of traffic congestion. According to Kuzmyak (2012), the usage of land has an impact on the amount and nature of traffic on the roadways. He adds that the type and density of activities near key arterial roads are related to traffic volumes.

Another factor responsible for traffic congestion is accident scene which block portion of the road or the entire route. If the accident scene is not cleaned up right away, congestion may develop and can quickly cover several kilometres (Rukunga, 2002). Congestion on Nigerian roads is primarily caused by inadequate

road capacity. According to Popoola *et al.* (2013), the main reason for traffic congestion on the Lagos-Ibadan motorway is a lack of suitable route capacity.

Potholes, trading activities, on-street parking, passenger loading and unloading, illegal transit stops, flooding/poor drainage, vehicle failure, narrowed road sections, religious activities, high volume of traffic, inadequate planning, lack of space for parking, poor road designs, and absence of traffic lights at some road intersections all contribute to road traffic congestion in major cities in Nigeria (Bashiru *et al.*, 2008; Momoh, 2011; Igwe, *et al.*, 2011).

Possible Effects of Traffic Congestion

There are three categories of effects associated with traffic congestion: social, economic, and environmental. According to Nushrat & Sanjay (2018), traffic congestion has a negative societal impact since it slows down transportation, causes accidents involving vehicles, encourages mass transit, causes delays, fosters road rage, overloads infrastructure, and poses security risks. Additionally, it puts commuters at risk for lifestyle ailments including high blood pressure, diabetes, and other illnesses connected to obesity. Due to prolonged exposure to poisonous chemicals like carbon monoxide and nitrogen oxides, sitting in congestion for a long time might also put one at risk for respiratory disorders (Mercyleen, 2013). For example, car travel in Europe produces 4-5 times more air pollution than train does (European Environmental Agency, 2021).

The cost of transit rises as traffic congestion worsens, either through increasing charges or increased wear and

tear as a result of frequent vehicle braking (Karimi *et al.*, 2021). Congested roads cause people to take longer to get to work, which results in lost working time and presents a significant problem to organisations (Bashiru & Waziri, 2008). It is challenging to predict journey time when there is heavy traffic. Elisonguo (2013) posited that the inability to anticipate travel durations and the consequent allocation of "just in case time" are secondary effects of traffic and road congestion. According to Weisbrod *et al.* (2003), an increased traffic congestion costs commuter's money and has an impact on business operations. They went further to argue that enterprises with large incoming delivery requirements are primarily impacted by traffic congestion, which lowers productivity. According to Collin (2015), economies would greatly benefit if transportation congestion could be cut in half. This claim supports the notion that traffic congestion has a detrimental effect on productivity.

Empirical Review

There are many studies on the difficulties of road traffic, notably in the field of traffic congestion. The Mauritius economy is used in a study by Vencataya *et al.* (2018) to identify the causes of the effects of traffic congestion on society, the economy, and individuals. The study also assesses the effects of traffic congestion on a number of other factors, including worker productivity, economic growth, commuter health and safety, travel dependability, and the environment. The use of 100 questionnaires allowed for the straightforward collection of information from daily Ebene and Port Louis travellers by the authors. The study's findings showed that the effects of traffic

congestion on society and the economy as a whole were detrimental. In addition to the study findings, respondents agreed that traffic congestion had a negative impact on society, the economy, and individuals.

In another study, Soham *et al.* (2018) investigated the causes and solutions to traffic congestion in Hinjewadi, Pune. The reconnaissance survey, which included a study of the area, interaction with local officials and experts, a review of previous investigations, volumetric study, road-side interview surveys, occupancy factor survey, origin- destination survey, speed and delay survey, and accident survey, was used to collect data for the study. According to the study's findings, factors including narrow roads, illegal parking, poor lane management, low occupancy rates, among others, contribute to traffic congestion. Building alternate routes or widening roads are the most frequently used strategies in these cities.

Using the examples of Calabar, Porthacourt, and Lagos, Joseph & Anderson (2012) explored the problems caused by heavy traffic on Nigerian roads. The authors used 300 questionnaires to gather information from professionals in transportation planning and the road users. However, the findings indicate that the main contributors to traffic congestion in Nigeria include poor driving practises, a poor road network, insufficient road capacity, and a lack of parking spaces. Their study's findings also show that the cities with the worst traffic congestion are Lagos, Port Harcourt, and Abuja.

The economic effects of traffic congestion in India are reviewed by

Muneera & Krishnamurthy (2018). The authors goal of the study was to review how traffic congestion affects delays, fuel use, and emissions. Furthermore, they look at the data needs and data collection techniques used in the literature on traffic congestion. The study came to the conclusion that hydrocarbon emissions, delays, and fuel consumption rates are all directly impacted by traffic congestion. The authors proceed to develop a methodology for estimating delay costs for linkages, intersections, and corridors as distinct facilities.

Raheem *et al.* (2015) investigated the causes, effects, and potential solutions of traffic congestion on Nigerian roads using the Basorun-Akobo road in Oyo state as a case study. The goal of the study was to identify potential reasons for traffic congestion, its impacts, and the solutions implemented to reduce it on Basorun-Akobo road. The researchers used an experimental investigation (traffic counting and delayed survey) to obtain the data. The study came to the conclusion that defects in the road, a shortage of parking spaces, and bad roads (potholes) are the main causes of road traffic congestion in Oyo-state.

Dammulla & Mudunkotuwa (2021) examined the Colombo metropolitan area's traffic congestion. The goal of the investigation was to answer important research concerns on the causes of present vehicle traffic, the effects of traffic congestion, and the opportunity costs of lost time and fuel due to congestion. 250 commuters in the Colombo metropolitan region were surveyed as part of the research using convenience sample. While correlation analysis was used to ascertain the association between the existing traffic

flow and infrastructure and development, growth of population and vehicles, unforeseen circumstances, events and incidents. The researchers discovered that a number of variables, including growth of population and vehicles, unforeseen circumstances, and events and incidents, each have a unique impact on the present vehicle traffic flow. In addition, the researchers identified time, fuel, earnings, and productivity as the primary effects of traffic congestion.

Using econometric and GIS Approach, Chao (2010) studied the relationship between traffic congestion and road accident. The study's analysis was based on information from the M25 and the key highways that surround it during the years of 2003 and 2007. The researcher examined the relationship between accidents and traffic congestion using classical negative binomial and Bayesian spatial models, as well as models of accident severity. The results of the model estimation imply that traffic congestion is negatively (i.e., inversely) related to accident severity and positively related to the frequency of fatal and serious injury accidents. It is discovered that the accident with minor injury is not significantly impacted by traffic congestion.

Olayiwole *et al.* (2014) conducted research on traffic congestion issues in Ikeja's CBD in Lagos state. The goal of their research was to discover the issues with management and traffic congestion in the Ikeja CBD. 200 questionnaires were used to collect information from drivers, and a quota sampling strategy was used to get pertinent information on traffic and transportation issues. The findings demonstrate that an unplanned pattern of land use leads to bottlenecks in

traffic and transportation, vehicular conflict, and needless traffic congestion, as well as longer journey times and low productivity.

In Nairobi city county's Jogoo road, Mercyleen (2018) investigated the socioeconomic effects of traffic congestion on urban mobility. The goal of the study was to examine the negative social and economic effects of traffic congestion and to provide solutions. Data was gathered using surveys, key informant interviews, focus groups, observation, and photography. The researcher determines that the main factors contributing to traffic congestion along Jogoo road are an increase in population, an increase in the number of private cars owned, inadequately designed roads with limited capacity, a lack of facilities for non-motorized transportation, unreliable public transportation, encroachment on the road's space, and an excessive reliance on one mode of transportation. The study concluded that traffic congestion has negative effects on both the economy and society, including longer travel times, higher petrol prices, lost business opportunities, health risks, environmental pollution, stress, fatigue, and less time spent with families because of early departures and late arrivals.

Takyi *et al.* (2013). examined the impact of traffic congestion on productivity in Ghana. Their research aims to determine how much traffic congestion reduces worker productivity in Kumasi metropolitan transport system. The study used a survey approach and focused on five of the city's main road connectors while utilising descriptive statistics to examine the data. The analysis's findings showed that Kumasi metropolis's limited

mobility is a result of congestion, which also adversely affects production by prolonging travel times, especially during peak hours.

In another study, Nushrat & Sanjay (2018) examined the causes and remedies for the traffic congestions in Maharaj Bada, Gwalior. The goal of the study was to learn about solutions for managing traffic congestion. The researchers came to the conclusion that inadequate traffic enforcement, narrow roads, illegal parking, a surge in population, poor lane management, and street sellers are to blame for Maharaj Bada's traffic congestion. However, the measures implemented to relieve traffic congestion in Maharaj Bada include prohibiting heavy motor vehicles from entering between the hours of 12 and 8, having traffic police maintain peak hour traffic management, keeping the vehicle lane clear from Gorkhi to Sarafa, and keeping all market entrances clear.

The causes, effects, and solutions to traffic congestion along the Lagos-Ibadan express were researched by Popoola *et al.* (2013). The findings of their study indicated that factors contributing to traffic congestion includes among others, insufficient road capacity, poor pavement, poor traffic management, poor drainage systems, poor driving and parking habits. The study further reveals that the negative effects of traffic congestion include time loss, movement delays, stress, accidents, the inability to predict journey times, usage of fuel, frustration with traffic, relocation, night driving, and environmental pollution. The study concluded by identifying measures like creation of parking space, building suitable drainage, widening of roads, and enlightening road users on traffic rules as

the possible remedies to traffic congestion.

Gabriel (2013) investigated the level of traffic around the Federal University in Akure, Ondo State. The researchers carried out a survey, discovered and catalogued the entities driving congestion. While information on congested intersections, roads, and land use regions was gathered via vehicle counting's and images. The study's findings indicated that the main factors contributing to traffic congestion in the study area are poor driving practises, weather conditions, the lack of traffic lights and/or traffic wardens, work zones, roadside parking, special events, a lack of public mass transit, a reluctance to use parking facilities, and bus stops.

Hao *et al.*'s (2008) research focuses on theoretical analysis and experimental observations of urban motorway congestion caused by intricate aspects of traffic flow, shock wave, and state transition. According to a study, the theory of shock wave speed can be applied to queue length control and the development of traffic control systems. Using GPS readings from major roadways in Bangkok, Thailand's urban districts, Pattara-Atikom *et al.* (2006) look into ways to gauge the levels of traffic congestion. In the study, categorization thresholds were determined using human perception, and the effectiveness of the suggested strategy was assessed. Roy *et al.* (2011) proposed an innovative and intriguing method for detecting traffic congestion on India's urban arterials. To identify the congestion, they propose employing a Wi-Fi signal producing device and a receiver across the road. This method was shown to be highly accurate in

identifying the route as crowded or free flowing. Sen *et al.* (2009) examined the characteristics of ITS approaches that need to be created to accommodate to traffic conditions and congestion in emerging regions, as well as a brief summary of a few attempts in this direction.

According to the literature review, there is still a gap in the research, notably in the study of the causes and effects of traffic congestion in Minna metropolis. As a result, the preceding study is intended to fill the gap by conducting volumetric counts around the major road intersections in Minna, as well as a survey to investigate the causes and effects of traffic congestion on road users.

RESEARCH METHODOLOGY

The study uses experimental investigation (i.e., volumetric counts) to determine the volume of vehicle and traffic composition around the major road intersection in Minna. While survey research was used to capture road user's perception on the causes and effect of traffic congestion on the road intersections. Need assessment was used to pick the major road intersection (i.e., Kpakungu Junction, City Gate Intersection, Dutsen-kura Junction, Mobil roundabout, Government Junction, Obasanjo roundabout, Barikinsa'ale Junction) in Minna. Using the 2006 population (i.e., 293,000) of Minna and the growth rate of 2.81%, the study project the 2023 population of Minna to be 468,544 sample (NPC, 2006; Authors' projection, 2023), while the Taro Yamane formula was used to identify 384 samples that were drawn for statistical testing, utilising random sampling as the method to distribute questionnaires to road users without bias. The questionnaires used are

divided into three main parts. The first section contains socioeconomic characteristics of road users, while the second part contains causes of traffic congestion, allowing road users to assess whether they agree or disagree with the variables producing road congestion. Furthermore, the third segment of the questionnaires addresses the effect of traffic congestion on road users. The questionnaire was designed to capture road users' perception on 5-point Likert scale where 1-represent strongly disagree and 5-represent strongly agree. The gathered data was analysed using mean index score, frequency and percentages while component factor analysis were used to reduce the components of the factors causing traffic congestion at major road intersections (i.e., presents road side market, increased population, inadequate parking lots resulting to on street parking, peak hour congestion, and poor road design). These key components were subjected to hypothetical test using Chi-square using the confident level of 0.05. However, the researchers provide a threshold of "3.00" to compare the mean index score of the causes and effect of road traffic congestion on road users. A mean index score above "3.00" indicate that the variable represents major cause of traffic congestion, mean index score "3.00" indicate that the variable moderately significant factor causing traffic congestion and mean index score

(MIS) less than "3.00" indicate less significant factor producing traffic congestion. Similarly, MIS below "3.00" indicate less effect, MIS "3.00" means that the effect is moderate and the MIS above "3.00" point that it has high effect.

RESULTS AND DISCUSSION OF FINDINGS

Socioeconomic features of Respondents

Table 1 displays the study of the road users' gender. According to the analysis, only 37% of road users are female, with men making up the majority (63%) of those who utilise the roads. The data in Table 1 from the analysis revealed the marital status of the road users in Minna. The analysis shows that a majority (i.e., 48%) of road users were married, 35% of them were still single, and just 17% of them had filed for divorce. However, the author could draw the conclusion that the majority of road users in Minna are married, and it's possible that their travel habits and mode of transportation preferences in the Minna metropolis are influenced by their marital status. According to the analysis of the educational backgrounds of road users, 34.4% of them have a West African Education Certificate, 33.0% have a National Certificate of Education or National Diploma, and only 15.6% have a bachelor's degree or a Higher National Diploma.

Table 1: Socioeconomic characteristics of the respondents

Dimensions		Frequency	Percentages
Gender	Female	104	37
	Male	178	63
	Total	282	100.0
Marital Status	Married	135	48
	Single	99	35
	Divorced	48	17
	Total	282	100.0
Educational	Primary School Cert	28	10
	SSCE/WAEC	97	34.4
	NCE/ND	93	33.0
	Bachelor's Degree/HND	44	15.6
	Postgraduate	20	7.1
	Total	282	100.0
Monthly Income (₦)	Below 30,000	49	17.4
	31,000 – 60,000	88	31.2
	61,000 – 90,000	80	28.4
	91,000 – 121,000	38	13.5
	Over 122,000	27	9.6
	Total	282	100.0
Occupation	Farmer	45	15.9
	Civil servant	67	23.8
	Self-employed	85	30.1
	Trader	42	14.9
	Student	43	15.3
	Total	282	100.0

Sources; Authors' survey (2023)

Similarly, Table 1, shows that only 7.1% of road users had postgraduate degrees, whereas 10.0% had school certificates. According to the data in Table 1, 31.2% of road users made between N31,000 and N60,000 per month, 28.4% made between N61,000 and N90,000 per month, and only 17.4% made less than N30,000. Table 1 further shows that just 9.6% of road users earn more than N122,000 per month, while 13.5% earn between N91,000 and N121,000. According to the findings in Table 1, 30.1% of road users were self-employed, 23.8% were civil servants, and only 15.9% were farmers. Similarly, 15.3% of road users were still students, while only 14.9% were traders. This interpretation allows the author to conclude that the various occupations of Minna's road users will result in distinct trip purposes, which

may influence congestion in specific zones.

Analysis of Vehicular Traffic Volume and Vehicle Composition at the Major Intersection of Minna Metropolis

The analysis in Table 2 reveals the vehicle traffic volume and composition at the major road intersections in Minna metropolis. It was observed in the analysis that Mobil roundabout has the highest traffic volume with a total of 4119 vehicles around the intersection. This is because Mobil roundabout is built in Minna Central Business District (CBD). Some of the factors attracting traffic to Mobil roundabout is as a result of the presence of motor parks, on street market and large number of peoples around the intersections. It was also observed that traffic around Mobil roundabout is high

in the morning, afternoon and evening of working days. Similarly, the close proximity of Minna central mosque and ECWA church around the Mobil roundabout was observed to generate an unusual traffic at certain day of the week (i.e., Friday and Sunday).

This was followed by the Obasanjo roundabout with a total of 3067 vehicles traffic. The roundabout was named after Obasanjo building complex where phones, laptops and their accessories are repaired or sold. The Obasanjo roundabout is connected to the Mobil roundabout and also provide access to Kure central market. The Obasanjo roundabout hold a significant traffic as the clients of the Obasanjo building complex business people park at the road sides causing motorist to reduce their speed. In fact, congestion on this route (Obasanjo roundabout) is very high between the period of 2:20-3.00 PM because of the Friday prayers as this route is shut-down for prayer.

Another road intersection where the vehicular traffic is high is City gate roundabout (with 2902 vehicular traffic). The roundabout serves as a traffic distribution points. It is the first roundabout road users access immediately they approach the city centres from Suleja and from this road intersection, road users can access many places in Minna metropolis. Congestions

on this intersection is caused majorly by Tricycle operators and intercity transport drivers who park on the road sides to transfer travellers and their baggage's to tricycle operators.

Also, Kpakungu roundabout in Minna is one of the major intersections which handle significant traffic, the Table 2 record that the road intersection handled 2000 vehicular traffic. It was observed that the congestion on this route is as a result of peak hour congestion particularly during the work days. Tricycle operators and motorcycle operators has their park at both side of the roundabout which constitute to obstruction of the traffic flow. In fact, on street markets were observed to constitute to traffic congestion around the Kpakungu roundabout.

Furthermore, Dutsen-Kura junction, and Barikin-sa'ale junction handle 1586 vehicle traffic and 1460 vehicle traffic respectively. Dutsen-Kura junction is significant for its traffic as it serves as feeder road to Government junction and Kpakungu roundabout and also provide access to the Kure Central Market. Additionally, Table 2 recorded a low traffic at the government junction. This low traffic (i.e., 484 traffic) maybe as a result of no activities generating traffic apart from the Niger state government house.

Table 2: Vehicular traffic volume and composition around the major intersection

Intersections	VEHICLE TRAFFIC COMPOSITION									
	LB	MC	PICK	C	TCY	SB	TT.	SpvArtv	Total	
Kpakungu Junction	98	214	16	984	508	78	26	4	72	2000
City Gate Intersection	111	331	10	1321	844	113	49	7	116	2902
Dutsen-kura Junction	34	248	23	729	412	62	15	6	57	1586
Mobil Roundabout	77	573	12	1823	1295	205	41	5	88	4119
Government Junction	6	152	3	220	86	11	2	0	4	484
Obasanjo Junction	38	435	31	1455	984	48	17	8	51	3067
Barikinsa'ale Junction	21	282	19	699	348	31	9	3	48	1460
Ground Total	385	2235	114	7231	4477	548	159	33	436	15,618

Note: B= luxury buses, MC= Motorcycles, PICK= pickup van, C= Car, TCY= Tricycle, SB= Small buses, TT= Trucks, Spv= Special vehicle and Artv =Articulated vehicles

Source: Authors' fieldwork (2023)

Similarly, the analysis in Table 2 shows the vehicles composition. From the analysis, it was noticed that cars (i.e., 7231 traffic), Tricycles (i.e., 4477), and motorcycles (i.e., 2235) are the highest contributors to traffic congestion on the major road intersection in Minna. This is followed by small buses (i.e., 548 traffic), Articulated vehicle (i.e., 436 traffic) and luxury buses (i.e., 385 traffic). However, pickup van (i.e., 114), special vehicles (i.e., 33) and trucks (i.e., 159) has the lowest contribution to traffic congestion at the road intersection.

Analysis of Factors Causing Traffic Congestion at Major Road Intersections

The analysis in Table 3 reveals that increased private car ownership (M= 4.0427), increased population (M= 4.0107), inadequate public transport service (M= 3.8470), peak hour congestion (M= 3.9075), poor road design (M= 3.8754), ineffectiveness of traffic signals (M= 3.8292), poor land use (M= 3.8149), noncompliance to road rules (M= 3.7402), absent of parking lots resulting to on street parking (M= 3.7865), the presences of road side market (M= 3.6833), religious worship/activities (M= 3.5290) and ongoing road maintenance (M= 3.1744) are the major factor causing traffic congestion around the major road intersection in Minna since their mean score exceeded the threshold of “3.00”.

Table 3: Factors responsible for traffic congestion

S/n	Factors causing traffic Congestion at the Intersection	Mean	Standard Dev.
1	Presences of road side market	3.6833	1.1446
2	Increased population	4.0107	1.0739
3	Absent of parking lots resulting to on street parking	3.7865	1.0909
4	Peak hour congestion	3.9075	1.0064
5	Poor road design	3.8754	1.1159
6	Noncompliance to road rules	3.7402	1.1117
7	Accidents	2.5110	.9834
8	Poor incident management on the road	1.9110	1.1569
9	Ineffectiveness of traffic signals	3.8292	1.0451
10	Bad roads	2.2256	1.0962
11	Poor land use	3.8149	1.0629
12	Inadequate public transport services	3.8470	1.3099
13	Poor driving behaviour	2.4256	0.4277
14	Ongoing road maintenance	3.1744	.9972
15	Increased private car ownership	4.0427	1.0168
16	Religious worship/activities	3.5290	.7840

Source: Authors' survey (2023)

Similarly, Table 3 points that factors like accidents (M= 2.5110), poor incident management on the road (M= 1.911), bad road (M= 2.2256), and poor driving behaviour (M= 2.4256) are less significant factors causing traffic congestion in the road intersections in Minna since their mean scores are less than the threshold of "3.00". Therefore, this analysis on the factor causing road traffic congestion at major road intersection in Minna is in line with the work of Popoola *et. al.*, (2013), Gabriel (2013), Dammulla & Mudunkotuwa (2021).

Analysis of the Impact of Road Traffic Congestion on Road Users in Minna Metropolis

The analysis in Table 4 reveals that the impact of traffic congestion on road users in Minna has a less effect since all the variables examined in Table 4 have a Mean Index Score below "3.00". However, comparing the intensity of traffic congestion in major cities of Nigeria (i.e., Abuja, Ikeja, Ibadan, Port Harcourt and Akure) to Minna indicates that the congestion in Minna is very less and has less impact on road users compared to the cities (Popoola *et. al.*, 2013; Gabriel, 2013; Joseph & Anderson, 2012).

Table 4: Impact of traffic congestion on road users in Minna

S/n	Impact of traffic congestion on road users	Mean (M)	Standard dev.
1	Time wastage	2.8648	1.2661
2	Higher transportation fare	2.5445	.9593
3	High fuel consumption	2.6548	1.1363
4	Longer journey time	2.6299	1.2005
5	Excess heat and discomfort	2.1957	1.0492
6	Higher chance of vehicle collision	2.4555	1.0415
7	Road rage	2.3843	1.1378
8	Higher costs of purchasing snacks and drinks in traffic	2.4911	1.1926
9	Decreased transport speed	2.4555	1.0551
10	Fatigue	2.6299	1.0343
11	Road users exposed to security threats	2.4623	1.0021
12	Disturbance from increased noise level from vehicle horns	2.6157	1.0428
13	Road users did not meet their daily target	1.7402	1.1681
14	Road users' failure to always keep to time	2.5445	1.0685
15	Road users spend more on transport fare	2.6121	1.0802

Source: Authors' survey (2023)

Test of hypothesis

H₀₁ There is no statistically significance to the 5 -key factor causing traffic congestion in Minna. In order to achieve the stated hypothesis, the sixteen (16) elements causing traffic congestions

identified in Table 5 was reduced into 5-key components causing traffic congestion around road intersections in Minna using component factor analysis which are shown in Table 5.

Table 5: Total Variance Explained

	Component	Initial Eigenvalues		Extraction sums of squared Loadings		
		Total % of Variance	Cumulative %		Total % of Variance	Cumulative %
1	4.869	32.459	32.459	4.869	32.459	32.459
2	1.690	11.264	43.723	1.690	11.264	43.723
3	1.509	10.060	53.783	1.509	10.060	53.783
4	1.192	7.945	61.728	1.192	7.945	61.728
5	1.030	6.866	68.594	1.030	6.866	68.594
6	.859	5.724	74.318			
7	.831	5.542	79.861			
8	.556	3.708	83.569			
9	.503	3.356	86.925			
10	.446	2.970	89.896			
11	.443	2.950	92.846			
12	.387	2.578	94.424			
13	.273	1.820	96.244			
14	.234	1.559	97.804			
15	.210	1.354	98.309			
16	.179	1.196	100.000			

Sources: Author's Survey (2023)

Table 5 showed the total explained variables. From the analysis, it was noticed that there were total of 16 variables which were evaluated as the factors causing traffic congestion around the major road intersection in Minna. however, the analysis reveals that presents road side market (4.869), increased population (1.690), inadequate

parking lots resulting to on street parking (1.509), peak hour congestion (1.192) and poor road design (1.030) has higher Eugene value more than 1. Therefore, these five factors were perceived by the road users as the most important factors causing traffic congestion around the major road intersections in Minna.

Table 6: Chi-square result

	Present roadside market	Increased population	inadequate parking lots	peak hour congestion	Poor Road design
Chi-Square	136.313 ^a	159.480 ^a	117.559 ^a	161.829 ^a	134.783 ^a
df	4	4	4	4	4
Asymp. Sig.	.000	.000	.000	.000	.000

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 56.2.

Source: Authors' survey (2023)

Table 6 showed the hypothesis result. From the analysis, it can be seen that the asymptotic significance for all the five variables is 0.000 which are less than 0.05. This implies that there is a statistically significant to the present of road side market (P-value =0.000), increased population (P-value=0.000), inadequate parking lot resulting on street parking (P-value =0.000), Peak hour congestion (P-value =0.000) and poor road design (P-value =0.000) which are the key factors causing congestion around the major road intersections in Minna.

total of 15,618

CONCLUSIONS

This study assesses the causes and effects of traffic congestion at major road intersections in Minna metropolis. In order to achieve this, volumetric counts were conducted to determine the vehicular volume and composition around the intersection as well as questionnaires survey to examine city perceptions on the causes and effect of traffic congestion at the major road intersections. From the analysis, the study reveals there are a

Assessment of the Causes and Effects of Traffic Congestion on Road Users in Major Road Intersection in Minna Metropolis

vehicular traffic around the major road intersection in Minna and private cars and tricycle contributed to the major traffic at the intersections. The study analysis also showed that the causes of traffic congestion in Minna Road intersections among others includes the presences of road side market, increased population and absence of parking lots resulting to on-street parking. The study outcome further shows that the effect of traffic congestion includes among others time wastage, higher transportation fare, high fuel consumption, and longer journey time. In conclusion, the overall effects of traffic congestion on road users were less when one compares it to mega cities of Nigeria. The study recommended that;

1. The Niger state government, through her agency, should prevent unlawful roadside markets. They can also inform Minna residents about the dangers of establishing markets along the road network.
2. Parking spaces near activity generation centres should be provided. While the government should occasionally

discourage residents from parking on the road by fining those caught in the act.

3. The government of Niger state should reintroduce public transit in Minna city in order to limit the use of private vehicles in Minna since private cars constitute to the increased vehicle volumes at the major road intersections.

4. The Niger state motor traffic division should implement stricter policies to deter poor driving conduct and penalise those who intentionally obstruct traffic flow.

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