

# Sokoto Journal of Geographical Studies (SJGS)



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# **Sokoto Journal of Geographical Studies (SJGS)**

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## TRAFFIC CONGESTION AND ENVIRONMENTAL SUSTAINABILITY IN BENIN METROPOLIS, EDO STATE, NIGERIA

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### Abstract

*Across the world, as the urban population grows, most cities are overwhelmed with more traffic challenges. The challenge of urban traffic congestion has become an incessant experience in urban spaces, especially in developing countries such as Nigeria. This research examines the impact of traffic congestion on the environment in the Benin metropolis. The research objectives are to ascertain the condition and state of traffic congestion within the Central Business District (CBD) of the metropolis. The research employed the use of a questionnaire survey as an instrument to elicit information from 385 adult respondents around the Central Business District. Given the assessment of CBD characteristics, the research reveals that the district is manned with diverse traffic regulatory mechanisms aimed at managing traffic congestion. The standardized beta coefficient of regression analysis showed that traffic congestion is impacted significantly by walkway trading, air pollution, and pedestrians' traffic, resulting in serious environmental challenges. The research captured a total of 73 traffic light locations, of which 59 were observed within the core zone, while the remaining 14 were discovered to be in the intermediate zone with no traffic light at the outer zone of the metropolis. The Kendall coefficient of concordance ( $W$ ) ascertained the extent to which the environment is impacted resulting from traffic congestion. The output result shows crime, poor traffic flow, and poor environmental conditions to be serious environmental challenges within the district. This research recommends that, on the aspect of traffic congestion mitigation strategy, expansion of roads, building of overhead bridge, and fixing bad roads were considered as major options in reducing the traffic congestion impact on the environment across the Central Business District.*

**Keywords:** *Traffic congestion, Central Business District, Environmental Sustainability, Traffic management and Benin Metropolis.*

### Introduction

In recent years, many countries have serious urban traffic congestion challenges in the process of urbanization (Fu, 2017). It has been described to be a major urban transportation problem (Aftabuzzaman, 2007). Given this, Vencataya et. al. (2018) described traffic congestion as the delay in the movement of vehicles due to limited road capacity. In other words, the problem of traffic congestion could be attributed to the effect of poor road infrastructure facilities, which tend to lag behind the traffic demand. Traffic congestion arises due to a high number of vehicles in the city's road networks, resulting in slow vehicular movement. Long vehicle queues are a common feature on urban roads when traffic stops. This gives rise to traffic jams with vehicles parked closely to each other, leading to longer journey times and delays (Dimri et al., 2024).

The problem of Traffic congestion is a phenomenon of most urban cities, which is often observed to occur during peak hours when the number of road users is at its maximum (Shaharuddin & Misro, 2023). Thus, on a global scale, Menichetti (2023) posited that traffic congestion is a present challenge in urban areas worldwide, which has negatively impacted both humans and the environment, causing extended travel times, economic losses and environmental degradation.

The burden of traffic congestion in urban areas on the environment, especially within the major cities of the world, stands in creating serious environmental implications and thereby jeopardizes environmental sustainability initiatives. The issue of traffic congestion is not only peculiar to the developing countries of the world, but the developed nations of the world have also been observed to have their fair share of the problem (Vencataya et al., 2018).

According to Lwesya et. al. (2021) stated that the effect of urbanization growth on the infrastructural development has often resulted in traffic problems. Limited transportation facilities, which include road spacing, parking area, signals and traffic management, give rise to traffic congestion (Rodrigue et al., 2009). Robert (2013) described traffic congestion as the unwanted by-product of excess mobility in cities around the world. The enormous cost of traffic congestion in the United States of America has been noted to include 87,606 crashes in work zones, 1,200 deaths, 37,476 injuries, 482 million hours lost in driver delays and \$ 6.5 billion lost time (Sanders, 2015) (as cited in Olagunju, 2015). Das and Keeste (2016) stated that traffic congestion around the central business district (CBD) of South African cities exudes remarkable consequences that include restriction on vehicular flow, creating vehicular and pedestrian conflict, increasing travel time and often resulting in frequent vehicular accidents. Most of the cities around the world have the profile of a central business district.

Chen et. al. (2020) described the CBD as the multi-functional mixed area where many people work, which also has the highest employment density. This district requires top-quality service facilities serving office workers during the day, diverse space for public use, restaurants, entertainment, culture and other activities. Daily, the CBD has numerous networks of roads converging vehicular passengers and tourists to that location, especially during the daytime. Henderson (2011) stated that as urbanization takes place and CBDs are created despite their advantages, they also pose negative effects on the surroundings and the people. It is widely accepted that cities of the future must become more sustainable, and that the transportation sector has a major role to play in this regard (Robert, 2013). It was further stated that efficient maximization and management of resources and the reduction of transportation costs can achieve economic and environmental sustainability. According to Morelli (2011), environmental sustainability in Nigeria, especially as it relates to traffic congestion in the cities, is a critical and pressing issue, given the country's rapid urbanization, industrialization, and population growth.

Oyeleye (2013) opined that most cities in Nigeria boast a CBD that serves as the economic and commercial heart of the city. Like many urban areas in Nigeria, the CBD of the city faces several environmental challenges, such as inadequate waste management, pollution (water and air), overpopulation, as well as the problem of traffic congestion. Thus, efforts to address environmental sustainability in Nigeria have gained momentum in recent years. It has been acknowledged through studies of scholars such as Kenworthy (2006), Koutonin (2016), Aliyu & Amadu (2017), and Onyenechere (2023), amongst others who opined that urbanization is an increasingly prominent global trend, with cities growing at unprecedented rates.

From an international perspective, studies have examined the environmental implications of CBDs in various contexts, highlighting common challenges such as transportation emissions, traffic congestion, energy consumption, waste generation, and loss of green spaces (Kennedy et al., 2007; Säynäjoki et al., 2014; Koko & Bello, 2023). In Bangladesh, Noor et al. (2021) state that urban development sustainability, especially around the CBD, is hampered by traffic congestion. The traffic congestion state was assessed using several indices and levels of service that showed a poor state of traffic flow in the CBD areas. The district is experiencing a large number of vehicles, a poor transport system, poor behaviour, and law enforcement. A similar study undertaken by Das and Keetse (2016) in South Africa indicates that traffic congestion in and around the central business districts (CBD) of South African cities is engendering undesirable consequences that include impeding vehicular flow, causing vehicular and pedestrian

conflicts, escalating travel time, and frequent vehicular crashes. The future peak hour traffic congestion levels will intensify and a high number of underutilised roads which pose a threat to the sustainability of CBDs.

In Nigeria, several studies have identified the challenges resulting from high population density and haphazard land use pattern, generating heavy vehicular traffic, leading to vehicular conflict and congestion as well as other mobility related challenges, inadequate traffic management as well as unauthorized usage to some roads specific to some vehicles within the CBD resulting in low productivity and loss of man hours (Olayiwola et al., 2014; Olagunju, 2015; Adelekan, 2019; Buhari et al., 2020, Onah, 2023). The high traffic congestion contributes to the negative impact on the environment and has led to increased road usage, business start-ups, an increase in vehicles and pedestrians due to CBD expansion (Aworemi et al., 2009; Ayo-Odifiri et al., 2017; Atewe & Egharevba, 2022).

Traffic congestion posed by the CBD impact the environment at large. For hawkers and people whose businesses are dependent on traffic congestion it is advantageous to them, while this congestion can also impact other businesses negatively, this can have economic repercussions, affecting tourism, property values, and business attractiveness within the area.

Traffic congestion associated with CBD in Benin metropolis raises significant concerns for the well-being of the city and its future development. This research is a bid to unravel the pressing challenges of traffic congestion faced by residents and its environmental impact in the central business district of the Benin metropolis.

### **Objectives of the Research**

The research objectives are:

- Identify the demographic and socio-economic characteristics of respondents in the Central Business District (CBD) within the Benin metropolis.
- Ascertain the spatial location of the traffic light within the district.
- Examine the state of traffic congestion in Benin metropolis.
- Ascertain the challenges and mitigating strategies associated with road traffic congestion.

### **Hypothesis**

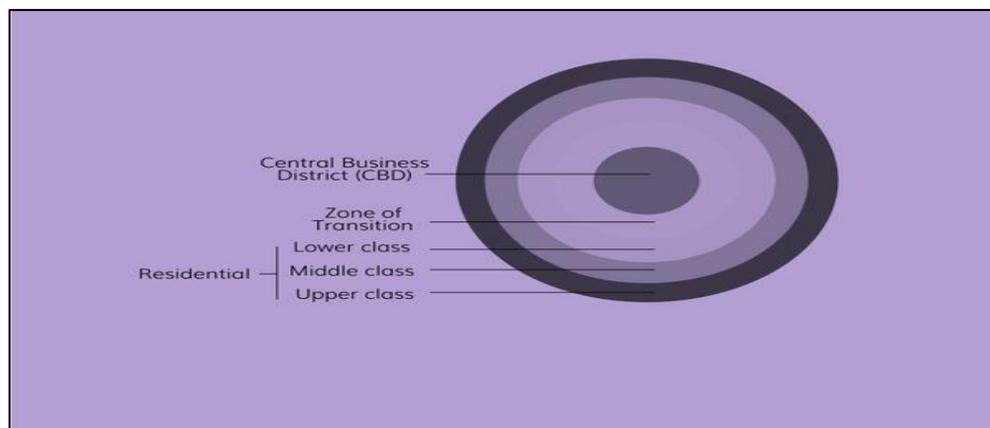
Ho<sup>1</sup>: There is no significant variation in traffic congestion across the concentric zones of Benin metropolis.

### **Conceptual Framework (Concentric Theory)**

The concept of Central Business District (CBD) was propounded in 1925 by Burgess. The model brought to view that the city expands from the inner to the outer in a way of concentric circles, which define the spatial structure (Yaguang, 2011). Thus, in this model, Burgess identified five zones which were meant to have different characteristics. The core of the city is known as the first zone. The second to fourth zones were designated as the zone of transition for poor residential areas, independent working areas, and better residential areas. The fifth zone is the commuter's zone, consisting of suburbs with men commuting to jobs in the CBD (Onah, 2023). Thus, the modern CBDs can be ascertained to reflect the following social-economic structure.

The geographical and serviceable centre of the city structure is regarded as the CBD (Yaguang, 2011). The Central Business District is regarded as the beehive of social-economic activities of the urban metropolitan area. Thus, the CBDs are always poised to have some unique characteristics. These characteristics could be attributed to being functional. This implies that the

CBD is designated as an area of high functional services. This area has the highest service centralization level and can provide extensive services for economy, management, recreation, culture and even administration (Yaguang, 2011). The CBDs are areas of high industrial and commercial characteristics. The district has higher land use and exploitation, raising the value of land. It is characterized by high population, building density and vertical building architectural form, and employment characteristics. Therefore, the CBDs constitute the basic engine house of any metropolitan urban cities, as it helped to re-engineer the social-economic landscape. Yu et al. (2015) stated that the traditional attributes of the CBDs, due to its location and desirability, are made up of retail business hot spots, while modern developing CBDs are a centralized and condensed space for different business runs by skilled workers, experts and other consultants. These are land zones having the maximum business concentration and land values. Thus, using this model, it is observable that the CBDs axis of the metropolitan Benin City is a plethora of diverse socio-economic activities, the intensity of which has helped to facilitate several negative externalities, such as traffic congestion of both pedestrians and vehicular movement and poor-quality environmental challenges.



**Figure 1: The Urban Land Use Model**

## Literature Review

The incessant growth in development which is being facilitated by the high level of urbanization process around the world have pushed urbanization and development in the central business district (CBD) forward at a very fast pace beyond the limits of its boundaries to all other adjoining areas (Nwachi et al., 2024). As cities continue to grow congestion problems become eminent. Faridi (2020) and Olayiwola et. al. (2014) stated that many CBDs of cities throughout the world experience many problems which range from congestion, lack of space, pollution. Urban congestion is a term used to describe the high volume of traffic and overcrowding in cities. It refers to the situation where there are more vehicles on the road than the infrastructure can handle, leading to slow-moving or standstill traffic. Researches posited that urban traffic congestion refers to the excessive crowding, traffic congestion, and overutilization of infrastructure in urban areas, resulting in inefficiencies in transportation, economic activities, and overall quality of life (Onyeneke, 2018; Abdul et al., 2020; Subair et al., 2024).

Climate change, disease burden and economic loss are some of the effects of traffic congestion on society and environment. About seventy percent (70%) of congestion are attributed to poor road infrastructure; poor traffic planning and a driver's conduct (Choudhary et al., 2022). The challenge of urban traffic congestion according to Ukpata and Etika, (2012) stated that the problems of traffic congestion are not only visible at local scale but also at global scale. They further stated that no matter the dynamics, and the level of liveability status of urban regions it will never be devoid of traffic congestion. It encompasses various forms of congestion, including

road congestion, public transportation overcrowding, and pedestrian congestion, and inefficient mass transport system amongst others are major causes of traffic congestion.

There are several factors that contribute to urban congestion, including population growth, inadequate transportation systems, and an increase in personal vehicle ownership. As cities continue to grow and attract more people, their roads become increasingly congested (Rodrigue et al., 2009; Yashaswi & Prashant, 2024). Urban traffic congestion has emerged as a serious problem affecting daily life, economic and the environment. Säynäjoki et al., 2014 and James (2024) made known that the relationship between the Central Business District and environmental sustainability is complex, and it often involves multiple factors, including urban planning, transportation, building design, and resource management. A business environment is naturally impacted based on the level of activities that are carried upon within that area. The transportation systems serving CBDs are instrumental in influencing environmental sustainability. Urban centres worldwide are facing unprecedented challenges in the 21st century, with Central Business Districts (CBDs) playing a pivotal role in shaping the environmental sustainability of these densely populated areas.

## Methodology

### Study Area and Methods

The research area lies within latitude  $6^{\circ}19'55.66''$  N and longitude  $5^{\circ}37'20.73''$  E. The area lies within the Oredo local government area in Benin City, Edo State (Figure 2 & 3). It spans approximately 25 kilometres and has been a vital component of the city's transportation network and Oredo LGA record 251,599 of that population who are 15 years and above (National Population Commission [NPC], 2010). The current population of Benin City is 2,044,650, since its establishment in 1976. The CBD stands as a prominent and historically significant study area in Benin City, Nigeria. This urban hub encapsulates a rich blend of cultural, economic, and social facets that contribute to the city's vibrant character. The core area of the CBD, alternate names such as King's Square and Oba Ovonramwen Square, reflect its historical importance. The square was named after the Oba and served as a central location for various historical events. According to Nkeki and Erimona (2018), the CBD is a testament to Benin City's cultural heritage. The characteristics of Benin City as a nodal city, which provides easy access to other parts of the country, have led to a rapid increase in its population growth. According to the 2006 population census conducted in Nigeria, Benin Metropolis has 1,086,882 inhabitants out of the 3.23 million of Edo State population (National Population Commission [NPC], 2010). The current population of Benin City is 2,044,650, with an annual change of 3.65% (72,090) people (World Population Review, 2024).

The Benin region is region has the characteristics propensity as an emerging commercial and industrial zone. The Igun community in the core area had helped the city to maintain an enviable status of blacksmithing, bronze casting and wood carving. In recent times, the area had witnessed a remarkable development in modern industries such as Guinness Nigeria Plc, Coca-Cola Bottling Company, 7up Bottling Company Plc, oil companies- NNPC, NPDC, IDSC, Pan Ocean and other numerous emerging food and wine industries. The metropolis's location in the country has assisted in attracting migrants and creating the inertia for commercial and other business activities (Ayo-Odifiri et al., 2021).

The central business district hosts a myriad of businesses, shops, and markets. It serves as a commercial nucleus, attracting entrepreneurs, traders, and shoppers. The vibrant street markets contribute to the lively atmosphere, offering a diverse range of goods and services, while the square boasts impressive architectural designs, blending historical structures with modern elements. The strategic urban planning enhances the area's aesthetics and functionality. Notable buildings around the CBD include financial institutions, government offices, and commercial



Using simple random sampling technique, across the three core areas on the seven major arterial roads, 385 copies of the questionnaires were randomly distributed at the eighteen (18) transportation terminals among drivers and traders; business owners and residents who gave their consent. Descriptive, regression, mean rank, Chi-square and Kendall coefficient of concordance statistical techniques were used to assess the impact of traffic congestion on the environment in the research area. To measure traffic volume, the numbers of vehicles that ply the seven major routes on both sides of the road were recorded for one minute. The volume of traffic was counted three times on the designated day in the morning, afternoon and evening. The data was analysed using the Statistical Package for the Social Sciences (SPSS 23 version), while maps were produced using ArcGIS 10.8.

## Results and Discussion

### Demographic and Social-Economic Attributes of Respondents

**Table 1: The Demographic and Social-Economic Attributes of Respondents across the CBD**

		CENTRAL BUSINESS DISTRICT (ZONES)			
		CORE ZONE	INTERMEDIATE ZONE	OUTER ZONE	TOTAL
<b>Sex of Respondents</b>	Male	103	70	50	<b>223 (58%)</b>
	Female	77	50	35	<b>162 (42%)</b>
<b>Age of Respondents</b>	18-29 years	13	9	8	<b>30 (08%)</b>
	30-41 years	66	42	29	<b>137 (36%)</b>
	42-53 years	70	40	38	<b>148 (38%)</b>
	54-65 years	30	23	9	<b>62 (16%)</b>
	Above 65	1	6	1	<b>8 (02%)</b>
<b>Education</b>	No formal education	7	3	1	<b>11 (03%)</b>
	Primary education	24	19	15	<b>58 (15%)</b>
	Secondary education	95	75	48	<b>218 (57%)</b>
	Tertiary education	54	23	21	<b>98 (26%)</b>
<b>Marital Status</b>	Single	7	3	2	<b>12 (03%)</b>
	Married	146	86	62	<b>294 (76%)</b>
	Widow	10	5	7	<b>22 (06%)</b>
	Divorce	12	10	8	<b>30 (08%)</b>
<b>Occupation</b>	Separated	5	16	6	<b>27 (07%)</b>
	Public Workers	5	5	6	<b>16 (04%)</b>
	Business Owners	78	37	54	<b>169 (44%)</b>
	Trader	31	68	18	<b>117 (30%)</b>
	Artisan	6	6	2	<b>14 (4%)</b>
<b>Monthly Income</b>	Driver	60	4	5	<b>69 (18%)</b>
	₦30000 below	63	54	1	<b>118 (31%)</b>
	₦30000-60000	24	39	16	<b>79 (20%)</b>
	₦60001-90000	80	3	8	<b>91 (24%)</b>
	₦90001-120000	10	23	47	<b>80 (21%)</b>
Above ₦120000	3	1	13	<b>17 (04%)</b>	
<b>Total</b>		<b>180</b>	<b>120</b>	<b>85</b>	<b>385 (100%)</b>

Respondent characteristics from the administered copies of the questionnaire are depicted in Table 1 across the CBD of Benin Metropolis. 58% of the respondents were male, while 42% were female. The socio-economic activities within the CBD Zones are not too gender sensitive, though more male seems to be involved in the socio-economic activities within the CBD. The analysis showed that the cumulative percentage of 82% of respondents indicates that a larger percentage of the respondents' range between 18-53 years of age, which happened to fall within the economically active population age group. It could also be inferred that the mobility level of this age group tends to be higher when compared to those from 54-65 years above. The marital status depicts that a larger percentage (76%) of the respondents are married compared to 24% who make up those who are single, widowed, divorced or separated from their spouses. The large number of married persons is positively related to growth in socioeconomic activities.

44% of the respondents interviewed for this research were observed to be business owners who have stores and business premises varying from small to large-scale businesses. 30% are traders engaging in the sale of goods, operating their business under open roof, as well as those who hawk their wares around the CBD zone. Drivers represent 18% of respondents working in various bus terminals across the CBD. They are regarded as road transport workers in the transportation sector, facilitating the movement of goods and services from one geographical area to another. The analysis revealed that many of the respondents earn below ₦30,000, followed by those who earn ₦60001-90,000. About 49% of the respondents earn above the current minimum wage of ₦70,000. This implies over 50% of the respondents cannot sustain their daily food and personal care.

### **Traffic Congestion Impact on the Environment**

Traffic congestion in Benin Metropolis tends to present some notable environmental characteristics. As part of substantiating the environmental challenges, the impact of traffic congestion across the Benin metropolis was analysed using a regression method. The coefficient of the regression analysis output result is shown in Table 2. Thus, the various environmental challenges impact of traffic congestion is measured by the standardized beta coefficient. The analysis result showed that traffic congestion tends to impact walkway trading, resulting in a serious environmental impact with a beta coefficient of 0.255, which happened to be significant, and followed by pedestrians' traffic beta coefficient of 0.232. The impact was also observed to be significant for air pollution with a coefficient of 0.175, bad road has a negative coefficient of -0.132, and observed to be significant.

This implies that as the quality of roads worsen (more bad roads), traffic congestion (environmental challenges) reduces across the metropolis. This result suggests a more complex relationship that could mean that bad road become non-motorable and motorist abandon such route leading to further congestion on motorable routes. The Beta coefficient of 0.031 was observed for waste and environmental blight respectively and they were not statistically significant. Helmi and Wahab (2023) report the social-economic and environmental impact of traffic congestion on road user. Our findings are similar to Ayuba et. al. (2025) in Nasarawa State. This clearly shows that the traffic congestion situation tends to create environmentally challenging condition for four out of the seven measured variables, which may not be good for the environmental liveability of the city. This quality condition may impact human health.

**Table 2: Regression Coefficient of Environmental Challenges)**

Environmental Challenges	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	T	
(Constant)	1.497	.158		9.489	.000
Walkway trading	.236	.045	.255	5.236	.000
Crime	.006	.049	.005	.120	.905
Bad road	-.125	.045	-.132	-2.791	.006
Pedestrians traffic	.200	.047	.232	4.240	.000
Air pollution	.167	.051	.175	3.270	.001
Waste pollution	.034	.054	.031	.633	.527
Environmental Aesthetic	-.036	.054	-.031	-.668	.505

Table 3 further depicts the ranks of the various challenges resulting from the traffic situation in the CBD. From the analysis, traffic congestion was observed with a mean rank of 2.4961. This implies that the majority of the respondents acknowledged this to be a serious challenge in the district. Traffic is one notable phenomenon that seems to characterize Benin Metropolis due to its busy nature, like most cities across the world. This is often necessitated by the diverse goods and services it has to offer in meeting the demand of the wider population. Walkway trading had a mean rank of 2.1714. Thus, more often than not, this socio-economic activity is seen to emerge whenever there is a serious traffic challenge. Noor et. al (2021) research in Bangladesh report similar poor traffic state in the CBD due to street vendor (hawkers). Egharevba and Edohen (2025) also reports that street trading worsens traffic congestion in Benin Metropolis. Severity of air pollution has a mean rank of 2.0779, which is followed by Crime impact with a mean rank of 1.7922. Pedestrian traffic with a mean rank of 1.7299, bad road mean rank of 1.7273, and waste pollution 1.5922 and environmental blight challenge which render the area unattractive with a mean rank of 1.5403. Fattah et. al. (2021) and Sani et. al. (2020) concurs that urban traffic congestion makes road unsustainable and unsafe for pedestrians and causes pollution.

**Table 3: Challenges from Traffic Situation in the CBD**

Environmental Challenges	Mean Rank
Traffic congestion	2.4961
Walkway trading	2.1714
Crime	1.7922
Bad road	1.7273
Pedestrian's traffic	1.7299
Air pollution	2.0779
Waste pollution	1.5922
Environmental Aesthetic	1.5403

### Traffic Light Location at the Core Zone

Figures 4 and 5 show the locations of traffic lights in the inner (Core) zone of Benin Metropolis. The distribution clearly showed that of the 73 traffic lights in the metropolis 59 of them are found in the core zone of the metropolis. The reason for such distribution could be attributed to the fact that the core zone constitutes the Central Business District of the metropolis. This happened to be the commercial beehive of the city, areas of high traffic operation, transport terminals and governmental institutions. So, the need for such concentration of traffic lights in the core zone becomes imperative due to the observed human and vehicular traffic that is often experienced in the district.

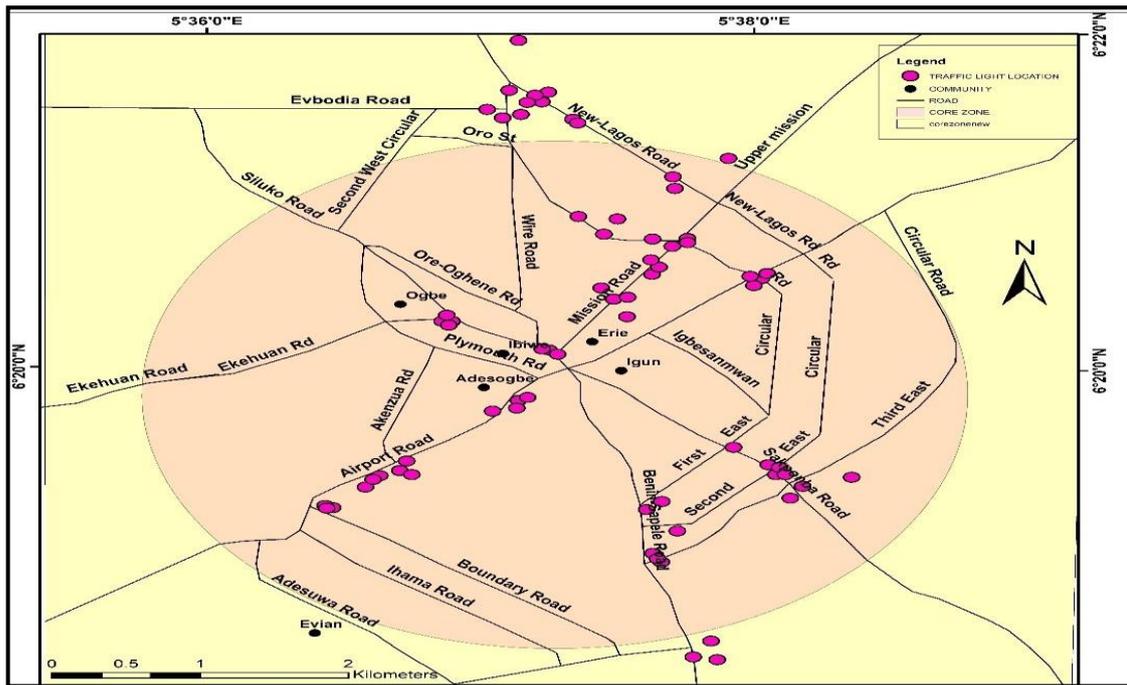


Figure 4: Spatial Location of Traffic Light in Benin Metropolis (Business Central District)

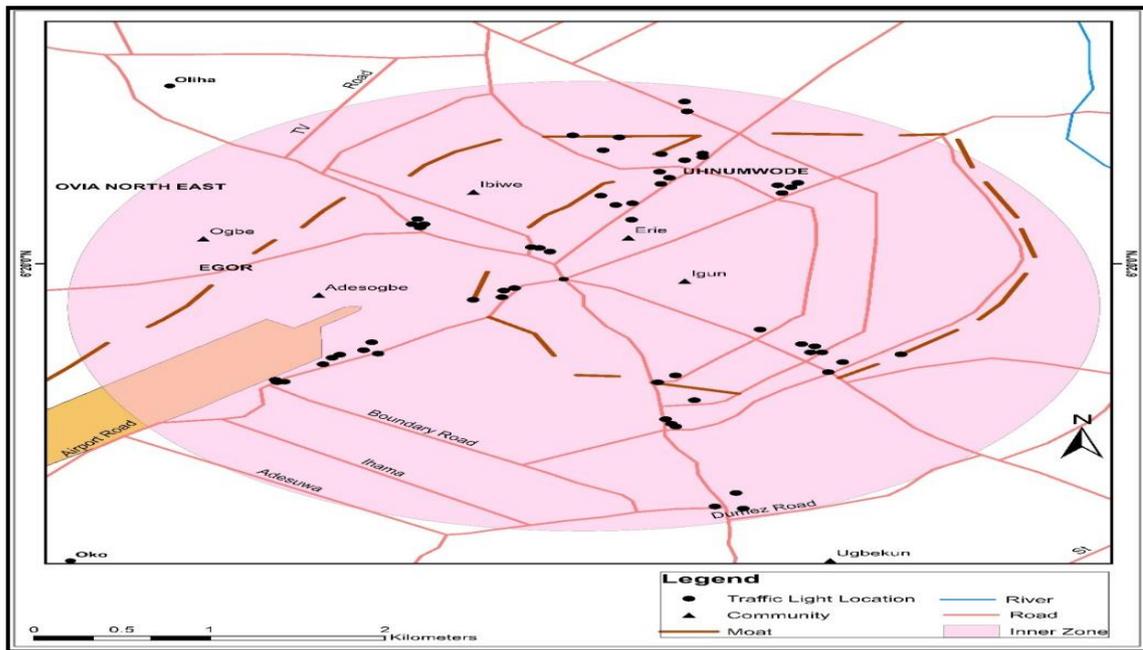


Figure 5: Location of Traffic Light in the Inner Zone of Benin Metropolis

The distribution of traffic light locations in the intermediate zone is displayed in Figure 6. Fourteen (14) traffic lights were found in the intermediate zone in the metropolis. The lower number of the traffic light at this zone could be attributed to the lesser traffic congestion when compared to that of core zone. This clearly shows that traffic light distribution is not evenly distributed across the metropolis. However, in the outer zone of the metropolis, it was observed that there were no presences of traffic lights.

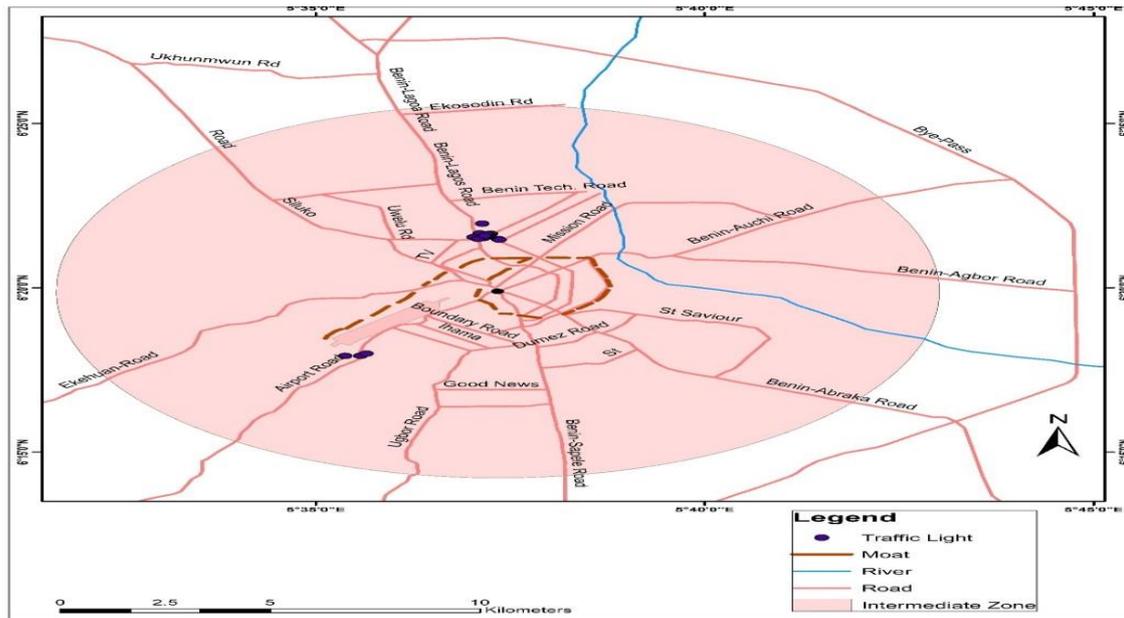


Figure 6: Location of Traffic Light in the Intermediate Zone of Benin Metropolis

### Assessment of Traffic Flow Measurement across Benin Metropolis

The state of traffic congestion across the major arterial roads within Benin Metropolis was assessed. Traffic flow measurement was carried out along the six major Arterial roads that transverse Benin metropolis. This was used to evaluate the traffic volume of the road links and also provide insight into the ease of transportation along these major roads. Thus, traffic count was carried out along the major roads in Table 4. The volume of traffic was highest along the Benin-Sapele road in the morning hour at 9 am, with 110 vehicles, 86 and 92 vehicles in the afternoon and evening. This is closely followed by the volume of traffic per minute from Oluku to Central Park Road, which recorded 102:76:82 vehicles during the same hours. Ekehuan road recorded 96:72:76 vehicles, while the traffic count at Akpakpava road was 92:62:72 vehicles. Other routes recorded the least Traffic counts of 56 vehicles at any scheduled hour of the day. However, the data indicates a remarkable variation in traffic volume along these various routes that cut across the metropolis.

Table 4: Traffic Volume Measurement during the Day

S/N	Name of Road	Functional class	Morning Count (9 am)	Afternoon Count (1 pm)	Evening Count (5 pm)	Average Traffic Volume Per Minute
1	<b>Oluku-Ugbowo Route</b>	Principal Arterial	102	76	82	87
2	<b>Urelu To Central Park</b>	Principal Arterial	75	68	62	68
3	<b>Wire-Road To Central Park</b>	Collector Road	65	62	56	61
4	<b>Mission Road</b>	Collector Road	72	56	62	63
5	<b>Akpakpava Road</b>	Principal Arterial	92	62	72	75
6	<b>Airport Road</b>	Principal Arterial	68	56	74	66
7	<b>Sokponba Road</b>	Principal Arterial	62	72	68	67
8	<b>Benin-Auchi Road</b>	Principal Arterial	58	56	60	58
9	<b>Ekehuan Road</b>	Collector road	96	72	76	81
10	<b>Benin-Sapele Road</b>	Principal Arterial	110	86	92	96
11	<b>Siluko-Road</b>	Collector Road	72	62	70	68
12	<b>Benin-Agbor Road</b>	Principal Arterial	56	58	62	59

The comparative analysis was computed using the average volume of traffic for the sampled routes. The result of the analysis shows that Sapele road 96 counts per minute, Oluku route, the average traffic volume per minute was 87 counts per minute. Next is the average traffic volume for Ekehuan Road and Akpakpava Road, with 81 and 78 counts per minute. Benin-Agbor Road had the least average traffic counts of 59 per minute in the metropolis.

### Assessment of Traffic Congestion within Benin City Metropolis

The hypothesis was validated using the Table 5 Chi-Square Test which states that there is a significant difference in traffic congestion across the concentric zones in Benin Metropolis. This is indicated by the Pearson chi-square P-value, which happened to be less than ( $P < 0.05$ ) than the adopted confidence level of 0.05. This goes to show that traffic congestion within the Benin Metropolis is influenced by the density of population and level of social economic activities, which were captured within the context of zonation, at the core, intermediate and outer zones.

**Table 5: Hypothesis Testing**

Chi-square test	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	145.833 <sup>a</sup>	4	.000
Likelihood Ratio	155.304	4	.000
Linear-by-Linear Association	113.702	1	.000
N of Valid Cases	385		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.82.

### Challenge Associated with Road Traffic Congestion

To examine the challenges associated with road traffic congestion, the Kendall coefficient of concordance was utilised in Table 6. The result shows that respondents rank poor environmental condition and air pollution to be high on the environment having minimum and maximum values of 1 and 4. Poor traffic flow management, criminal activities, environmental challenges, and commercial activities have a maximum value of 5 and a minimum value of 1.

**Table 6: Challenges of Road Traffic Congestion**

Traffic Congestion Impacts	N	Mean	Descriptive Statistics		
			Std. Deviation	Minimum	Maximum
Poor traffic flow management	385	1.9065	.82385	1.00	5.00
Poor environmental condition	385	1.9091	.49953	1.00	4.00
Criminal activities	385	1.3117	.55103	1.00	5.00
Air pollution	385	2.0545	.64520	1.00	4.00
Environmental challenges	385	3.8156	.73935	1.00	5.00
Commercial activities	385	2.9922	1.44606	1.00	5.00

The mean rank of traffic congestion impacts on the environment is displayed in Table 7. The result of the analysis showed that the respondents ranked the impact of criminal activities with a mean rank of 1.94 as the most environmental impact, which is followed by poor traffic flow resulting from traffic congestion with a mean rank of 3.01. Poor environmental condition with a mean rank of 3.11 was observed to be the third environmental impact due to traffic congestion. Air pollution resulting from traffic congest impact was ranked 3.35 as the fourth environmental impact of traffic congestion by the respondents. The commercial/Business impacts the area, with a mean rank of 4.14, was assessed to be the fifth environmental impact resulting from traffic congestion, while the environmental challenge of traffic congestion was accorded a mean rank of

5.45. Similar report on crime was reported by Kalinic and Keler (2018) in San Francisco. The research shows a spatial connection of areas with traffic congestion and crime hot spots.

**Table 7: Environmental Impact of Traffic Congestion**

<b>Environmental Impact of Traffic Congestion</b>	<b>Mean Rank</b>
Poor Traffic flow management	3.01
Poor Environmental Condition	3.11
Criminal activities due to High traffic condition	1.94
Air Pollution	3.35
Environmental Challenge	5.45
Commercial/Business impact	4.14

To validate the relationship in the level of agreement among the respondents on traffic congestion is shown in Table 8. Computed at P-value (0.478) was observed to be greater than the adopted confidence level of 0.05. This showed that there is significant level of agreement among the respondents on the impact of traffic congestion on the environment in Benin Metropolis. This result concurs with findings from several researches on the social, economic and environmental impacts of traffic congestion in several cities (Das & Keetse, 2016; Noor et al., 2021; Atewe & Egharevba, 2022; Helmi and Wahab, 2023)

**Table 8: Kendall Coefficient of Concordance Test of Traffic Congestion on the Environment**

<b>N</b>	<b>385</b>
<b>Kendall's W<sup>a</sup></b>	<b>.478</b>
<b>Chi-Square</b>	<b>919.700</b>
<b>Degree of freedom (df)</b>	<b>5</b>
<b>Asymp. Sig.</b>	<b>.000</b>
<b>a. Kendall's Coefficient of Concordance</b>	

### Mitigation Strategy in Reducing Traffic Congestion in CBD

The mitigation strategies in reducing traffic congestion are displayed in Table 9. 54% of respondents advocate for the expansion of roads. This is important for ease of vehicular movement, especially during peak hours. Building overhead bridges and bypasses is another strategy that 24% of respondents claim will reduce traffic congestion. This measure will assist to diverting traffic from congested locations within the city, saving the time of the drivers and commuters. 14% of the respondents declared that the bad road should be fixed to reduce traffic congestion. It has been observed that the bad roads situation within the metropolis seriously hampers the flow of vehicular movement, and the situation is worse when it rains. The effect of this is that it often leads to loss of man hours, financial resources and breakdown of vehicles along the routes. The need to ensure collector and adjoining roads are in good condition will lead to high utilisation and decongestion along major routes. Other measures will also help to create environmental liveability and sustainability, with fixing faulty traffic lights and restrictions on street trading will ease traffic situation and create aesthetic environment within the metropolis.

**Table 9: Mitigation Strategy in Curbing Traffic Congestion in Benin Metropolis**

<b>Mitigation Strategy</b>	<b>Frequency</b>	<b>Percentage</b>
Fixing of Bad Road	55	14
Expansion of Road	207	54
Building overhead Bridge/Bye-Pass	93	24
Restriction on Hawking in CBD	11	3
Repairing Traffic Light	19	5
<b>Total</b>	<b>385</b>	<b>100.0</b>

## **Conclusion and Recommendations**

The research finding observed the age composition to lie within the active working population of diverse occupational status ranging from business owners, traders, drivers amongst others. These diverse characteristics of the respondents depict majority earning poorly, provides a wider based overview on the environmental impact of social-economic activities on traffic challenge. The regression analysis revealed that traffic congestion in Benin metropolis impact more on walk-way trading, pedestrians' traffic, and air pollution. It is obvious that the presence of traffic congestion often results in environmental challenging situation in the metropolis. The research findings show uneven distribution of traffic light and this skewed distribution could be inferred to be due to the intensity in traffic congestion usually experience at the core zone of the metropolis. It was also observed that there were no traffic lights at the outer zone of the city. Manual traffic flow measurement showed remarkable variation in the volume of traffic across the major arterial routes, with Benin-Sapele road having the highest traffic volume, followed by Oluku axis route.

Despite the numerous regulatory mechanisms put in place to curb the challenge of traffic congestion in the core zone, the intensity of the traffic congestion had remained unabated along some major routes. The road infrastructural planning had been observed to have failed in addressing the volume of traffic within the metropolis, especially as the metropolis expands and urban population grows. Respondents suggested mitigation strategies in curbing traffic congestion in the Central Business District CBD, such as expansion of road, building of overhead bridges, fixing of bad roads, repairing traffic lights, and restriction of hawking within the (CBD). To curb the challenges of traffic across the metropolis this research suggests for the expansion of roads in major arterial road with most traffic, building of overhead bridge, fixing of bad roads, restriction on hawking and pedestrian walk trading, and increase the use of public Bus Rapid Transit (BRT) instead of small commercial minibuses within the Central Business District to reduce number of vehicles on the road as well as fixing of faulty traffic lights.

This research recommends that state and the local government enforce all existing traffic laws and regulations across the Benin metropolis. This has policy implication to justify further investments in sustainable transportation infrastructure. This should include increasing public transport networks; strategic locations of the pedestrians' infrastructure and BRT system for effective mass transit. Enhanced traffic management systems through traffic light location which should be extended to the outer zone of Benin Metropolis and not restricted to the core and intermediate zone of the metropolis. Creation of pedestrian cross walk traffic light This will provide added value to the operation of traffic regulatory officers in the metropolis. Environmental sustainability should be advocated in terms of keeping the environment clean and healthy from the negative outcomes of traffic congestion, such as air pollution, bad road infrastructure, crime and refuse. Local businesses and community needs to curb the negative and harmful impact of street trading and initiative participation through effective policing to assist in the control of traffic challenges within their locality.

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