DIGITALIZATION OF TRAFFIC MANAGEMENT IN NIGERIA: AN ASSESSMENT OF THE TRAFFIC LIGHT IN CALABAR METROPOLIS, CROSS RIVER STATE

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Abstract

This study examined the digitalization of traffic management in Nigeria: an assessment of the traffic light in Calabar Metropolis, Cross River State. Specifically, the study sought to investigate if the installation of traffic light has helped to eased long vehicular queues among motorists in Calabar Metropolis, examine if traffic congestion related clashes among motorists have reduced due to the installation of digitized traffic lights in Calabar Metropolis and ascertain if unguided roadside parkings of vehicles by motorists have been regulated due to the installation of traffic lights in Calabar Metropolis. The study adopted the survey design and the sample size for the study was 210 respondents from Calabar South and Calabar Municipalty respectively. The instrument of data collection was the questionnaire and the data collected was analyzed using the chi-square technique. From the chi-square result, it was indicated that the installation of digitized traffic lights have not significantly helped to ease long vehicular queues among motorists in Calabar Metropolis, Traffic congestion related clashes among motorists have significantly reduced due to the installation of digitized traffic lights in Calabar Metropolis and unguided roadside parkings of vehicles by motorists have not been significantly regulated due to the installation of traffic lights in Calabar Metropolis. Based on the findings of the study, it was recommended that the State government should install adequate digitized traffic lights in Calabar Metropolis to help curb long vehicular queues. the authorities concern should replace faulty digitized traffic lights that are not functioning in Calabar Metropolis so as to assists in curbing traffic congestion related clashes, long vehicular queues and unguided roadside parkings and the State government should ensure that adequate digitized traffic lightsare installed in Calabar South Local Government Area to help control traffic congestion related clashes, long vehicular queues and unguided roadside parkings.

Keywords: Digitalization: Traffic Management; Nigeria; Calabar Metropolis; Chi-square
JEL: 03;Y8; Z0

1. Introduction

Transport is crucial to a nation's growth since it influences all facets of life (Ogunbodede, 2008; Solanke, 2013). Consequently, transit is an essential element in an urban environment. Modern existence would be unfeasible without mobility, since it is crucial for the transportation of people, commodities, and knowledge (Salau, 2015). Transport is the cornerstone of urban economies worldwide, facilitating communication and the trade of goods among individuals (Mahabir, Crooks, Croitoru & Agouris, 2016).Nigerian cities have seen ongoing growth, resulting in transport provision lagging behind demand, which has led to escalating urban mobility issues despite potential inside these areas (Ogunbodede, 2008; Solanke, 2013).

The challenge of urban mobility emerged with increasing urbanisation and population growth, resulting in issues such as traffic congestion. This is a primary factor influencing the extent of physical development in Nigerian cities (World Bank & UNCHS, 2016 & Amelsfort, 2015).One of these difficulties is traffic congestion, a condition on road networks that occurs with heightened use and is associated with reduced speeds, extended trip durations, and longer queues of vehicles. Congestion occurs when traffic demand exceeds the capacity for vehicle contact, resulting in a diminished flow of traffic. It is important to recognize that traffic congestion occurs when urban transport networks are unable to accommodate the amount of traffic they receive. Ogunbode (2007) and Odeleye (2008) assert that this situation is precipitated by the rapid proliferation of automobiles and the inadequate advancement of the road infrastructure.

Congestion is attributable to many specific issues, including negligent driving, noncompliance with traffic signals, substandard vehicles, and insufficient road maintenance. The majority of these diminish a road's capacity at a certain point or over a defined distance, or they increase the number of vehicles required for a specified quantity of passengers and cargo. Digitalisation can address issues arising from road congestion and provides novel ideas for enhancing traffic management. Intelligent Transport Systems (ITS) use sensors, cameras, and communication technologies to gather real-time traffic information.

This data may be used for several applications, including optimising traffic signal timing, implementing dynamic signage, and offering route assistance to vehicles, so enhancing traffic flow efficiency. However, the efficacy of digital traffic management relies on dependable infrastructure to enable efficient traffic control.With the continuous rise in urban populations and motor traffic, traffic administration and gridlock have become significant issues in metropolitan environments. These factors have led to prolonged waiting periods, fuel wastage, and environmental pollution (Kurdi, 2014; & Traffic Management Centre (TMC), 2014). The adverse impacts are especially pronounced in developing nations such as Nigeria, where infrastructure development is hindered by financial constraints and bureaucratic obstacles. Consequently, it is imperative to implement a rapid, cost-effective, and efficient sophisticated traffic management system that delivers traffic statistics to commuters and mitigates congestion problems (Lokesh & Reddy, 2014).

Traffic congestion is a significant concern in metropolitan areas across Nigeria, including Calabar Metropolis in Cross River State (Bassey, 2023). This congestion is due to reasons like population growth, insufficient public transit alternatives, and ineffective traffic management systems. Traffic congestion makes life in metropolitan centres such as Calabar Metropolis unbearable. The crowded traffic in Calabar Metropolis results in both air and noise pollution. Emissions from automobiles, including nitrous oxide (NO2) and carbon monoxide, provide health risks to the population of Calabar Metropolis and the environment. With the rise in traffic, the frequency of road accidents also rises.

The primary causes of deaths are traffic accidents resulting from excessive speed, overtaking, and non-adherence to road traffic signals (Sulkami & Ade, 2017). A survey from the World Health Organisation designated Nigeria as the most perilous nation in Africa, with an annual mortality rate of 33.7 fatalities per 100,000 people. Economic Intelligence Magazine's investigation showed that among 49,867 individuals engaged in traffic accidents from 2013 to 2015, 15,011 were fatalities and 34,856 sustained injuries.

These underscore the reality that traffic accidents have badly affected lives and property. It has been projected that, without intervention, road traffic accidents would emerge as the fifth major cause of mortality by 2030.The current traffic management system, which relies on a time constant, is deficient in intelligence and has the capacity to address these issues, particularly as many metropolitan areas in Nigeria transition towards smart cities (Salisu, Sadiku & Tonga, 2019).

To mitigate traffic issues in Calabar Metropolis and alleviate their adverse effects, the Cross River State administration has implemented digitalised traffic signals at key locations for efficient traffic control and management. Nonetheless, a substantial traffic congestion persists throughout the city. Incorporating protracted vehicular incidents and traffic-related complications. The inquiry is: has the implementation of traffic lights contributed to the alleviation and regulation of traffic congestion among drivers in Calabar Metropolis? Has the installation of traffic signals reduced conflicts among motorists connected to traffic congestion? Has the regulation of unguided roadside parking among motorists occurred owing to the placement of traffic lights? This research examines these and several more factors.

The primary aim of the research is to analyse the digitalisation of traffic management in Nigeria, specifically evaluating the traffic lights in Calabar the city of Metropolis Cross River State. This research is organised into five components. Section one contains the introduction, section II examines the literature review and theoretical framework, while section three focuses on the methods. Section four concentrates on the presentation of data, analysis, and discussion of findings, whilst section five provides the conclusion and policy suggestions.

2. Literature Review and Theoretical Framework

2.1 Conceptual Framework

Concept of Traffic Management

Traffic management is regulating the movement of vehicles within a designated region to mitigate congestion and enhance safety. Traffic management generally encompasses traffic control strategies like lane closures, speed regulations, one-way roads, and turn limitations. Traffic specialists use mathematical equations to analyse traffic patterns and utilise this information to design more effective traffic management strategies. Traffic handling is an approach that requires continual adaptation to changing situations.

Consistent assessment and assessment of the efficacy of traffic management methods is crucial to guarantee their relevance to the current traffic conditions.

Traffic management is crucial for ensuring secure and efficient movement of vehicles. The objective of any traffic management approach is to mitigate congestion and enhance safety. An effective traffic management strategy may mitigate the likelihood of traffic accidents and decrease the duration individuals spend in congestion.

2.1.2 The Concept of Traffic Congestion

Road traffic congestion occurs when an urban road network can no longer support the volume of traffic, leading to impediments among vehicles due to the relationship between speed and flow as the transport system nears its capacity (Goodwin, 1997; Ogunsanya, 2002). Traffic congestion is persistent and is mostly caused by the volume of vehicles, largely due to traffic accidents (US Federal Highway Administration (FHA), 2008).

Traffic congestion is a transportation situation marked by reduced speeds, extended travel durations, and heightened vehicle queuing. Traffic congestion on metropolitan road networks has significantly increased since the 1950s. Congestion occurs when high traffic demand causes vehicle interactions to impede the flow of the traffic stream.

2.1.3 The Concept of traffic lights

Traffic lights are signalling apparatuses located at road junctions, pedestrian crossings, and other sites to regulate the flow of traffic. Traffic lights typically have three signals that convey significant knowledge to road users via colours and symbols, incorporating arrows and bicycles. The standard traffic light colours are red, yellow (or amber), and green, positioned either vertically or horizontally in that sequence. Despite worldwide standardisation, discrepancies in traffic signal sequences and regulations occur at both national and municipal levels.

2.2 Literature review

2.2.1 Traffic Lights and Traffic Congestion

In their 2023 study, Ali, Brek, and Bouakkez developed a simulator that constructs a traffic grid with traffic lights at intersections identical to those within big cities, optimising vehicle flow through the grid by creating algorithms for the changing states of the traffic lights. To optimise vehicular flow over the grid, algorithm for scheduling are being devised to regulate alterations in road traffic. Due to the positive feedback on our models, they successfully attained results that decreased the period of waiting by 30% relative to the standard model.

Hyunjin, Syed, and Yujin (2020) propose a Q-learning-based traffic signal control system that optimises vehicle throughput at intersections while balancing signal timings among routes. The primary advantage of this research is its QL structure, which may be used at several crossings. The suggested approach utilises various waiting queue lengths to compute incentives after an analysis of four distinct performance crossovers. The proposed technique exhibited favourable results regarding the standard deviation of queue lengths, together reduced waiting times and queue lengths.

The research conducted by Nabila, Salah, and Mawloud (2019) introduced three synchronisation techniques to enhance traffic light management at signalised junctions.

Upon the arrival of the negotiating cars, the ICANP (intelligent context-aware negotiation protocol) first halts the green timer for the standard vehicle phases, facilitating the swift passage of the negotiating vehicles through the designated junction. The ICANP has achieved substantial reductions in vehicle negotiating wait times. Total wait times at each fire rose by 65% compared to the circulator and shown a 42% improvement over ITLC (intelligent traffic light controlling) (Neelakandan, Berlin & Tripathi, 2021). The authors also provide the Negotiations Protocol Based on Reputation (NPBR). This strategy aims to mitigate the adverse impacts of unauthorised vehicle entrance congestion.

It uses the drivers' reputations to assess the quantity of fraudulent automobiles. Compared to ITLC and ICANP, NPBR decreased car negotiation wait times by 64% as well as 45%, respectively. This paper presents an Intelligent Context Prioritisation Process (ICAPP). The highest priority cars get final evaluation. ICAPP states that they can traverse the bridge without the need for negotiation. The wait time for priority vehicles was halved using ICAPP compared to CATLS (context-aware traffic light scheduling, Younes & Boukeche, 2016).

Roopa, Ayesha, Rajkumar, Venugopal, Iyengardy, and Patnaike (2020) proposed a dynamic congestion management system aimed at maximising throughput, using social factors derived from interactions based on social, behavioural, and preference data (D-TMSA). The following information is provided in the paper's annotations: 1. A dynamic congestion management system using several relationship types enhances the overtaking rate and facilitates traffic flow. 2. Optimise non-conflicting traffic flow using dynamic structure. Optimise flow to regulate traffic signals and enhance the volume of flows.

The simulation findings indicate that the D-TMSA outperforms prior efforts by attaining elevated throughput, minimising overall trip time, and lowering the median amount of time to enhance traffic flow via their social interactions.Aleko and Djahal (2020) presented the Adaptive Traffic Light Control System (ATLCS) to assist traffic management authorities in efficiently addressing urban traffic congestion. The primary objective of ATLCS is to coordinate several traffic signals controlling neighbouring intersections by postponing the intervals at which each light turns green in a specific direction. To reduce the frequency of the "stop and go" phenomena, this delay is adjusted in real-time according to the amount of cars queued at each intersection. This enables cars leaving the city centre to go considerable distances without interruption, hence reducing their trip time. In comparison to non-synchronized fixed time Traffic Light Control Systems, the median duration of travel for vehicles moving in the synchronised direction has been markedly decreased (by as much as 39%), as shown by the performance evaluation of ATLCS.

Furthermore, an overall improvement of 17% was achieved throughout the whole simulated road network. Joo, Ahmed, and Lim (2020) proposed queue length standard deviation and throughput as the primary parameters for a Q-learning-based traffic signal management system in their research. The suggested approach demonstrates superior performance regarding the standard deviations of queue lengths, including reduced waiting times and queue lengths, in comparison to prior studies using Q learning. The traffic signal administration system is said to have identified the direction of traffic flow and allocated lights accordingly. This research examined traffic signal control applicable to various junction types.

2.2.2 Traffic Accidents and Traffic Light

In order to establish appropriate re-timing for intersections along the investigated road, Rafidi and Hamid (2014) investigated the amount of automobiles on Jalan Bukit Gambier and documented the traffic timing. The results of this study lend credence to the hypothesis that the synchronisation of traffic signals on major thoroughfares will significantly enhance traffic flow. Huth et al. (2015) performed a roadside study to examine the activity and utilisation of mobile phones when the light on the road was red. A cohort of normal driving activities and 124 mobile phone users were analysed at intersections. A connection between mobile phone use and delay was assessed in instances where traffic awareness was compromised. Despite the fact that drivers tended to cease using their mobile phones when the traffic signal turned green, it was observed that standard driving practices were not adhered to.

The traffic behaviour of 39 juvenile participants who exhibited typical driving actions and secondary task actions was examined by Catalina Ortega et al. (2021). Distracted drivers were found to have committed substantial violations in terms of vehicle control when contrasted with drivers who exhibited typical driving behaviours. The burden among drivers was observed to increase as a result of the use of cell phones while travelling.

The driver behaviour of the first two automobiles that were waiting at red signals was the subject of an investigation by Gjorgjievski et al. (2021). Three distinct observational parameters were considered: demographics, diverting behaviours, and their response to traffic signals. In general, an automotive that continued stationary for a period exceeding two seconds after the traffic signal transitioned from red to green was regarded as delayed. It was noted that 608 of the 1008 drivers included in the study encountered distraction at traffic signals. The most prevalent form of distraction was identified as in-vehicle preoccupation, with a rate of 44.8%. The percentage of individuals who used mobile phones was 7.4%. It was discovered that 126 drivers exhibited delayed behaviour, and 88.1% of these drivers were distracted.

Sieklicka et al. (2022) conducted research on the behaviour of vehicles at a signalised intersection during periods of high traffic. Drivers were required to pause at least once at a red signal in the event of excessive traffic. The results of the field research indicated that 60% of drivers who had halted their vehicles after the red light had illuminated were using their mobile phones. Furthermore, the survey findings indicated that less than 40% of drivers acknowledged engaging in this conduct.

Bakhtari Aghdam et al. (2022) conducted a study to investigate the conduct of drivers at traffic signals. Behavioural patterns were observed during the early morning, noon, and late-night hours in the study, which involved 946 drivers. They discovered that 13.6% of drivers at traffic signals were using mobile phones. Furthermore, it was determined that the rate of mobile phone utilisation among female drivers was twice the amount of male drivers. It was noted that drivers aged 26–40 and 41–50 used cellular phones less frequently than those under the age of 25.

Sharma et al. (2022) completed a study on the calculation of stationary gasoline consumption at signalised intersections. The dormant petroleum consumption of a total of 341 vehicles was assessed. Approximately 950 intersections in Delhi were evaluated in the survey itself. Greenhouse gas emissions were estimated in addition to petroleum consumption. Upon examination of the results, it was observed that 9036 L of petrol, diesel, and LPG were consumed. Furthermore, an estimated 37 tonnes of CO2 emissions were generated each day.

2.2.3 Unguided Roadside Parking and Traffic Light

Biswas, Chandra, and Ghosh (2017) endeavour to evaluate the worldwide state-of-the-art regarding the numerous repercussions of on-street parking, both good and negative, within an urban road setting, and further investigates the effectiveness and degree of these consequences. This research concludes that parking on the streets should be limited on important roadways. It may be permitted on small roadways since it has the capacity to enhance safety for road users in that setting. When permitted, on-street parking ought to operate parallel rather than angled, since the latter poses hazards in several aspects. The report further advocates for the restriction of on-street parking in proximity to certain particular areas, such as designated pedestrian crossings, intersections, and schools.

Canmanie and Donmez (2020) performed an on-road instrumented car research with 28 participants travelling in downtown Toronto, Canada, to investigate the impact of looking for parking on the street on drivers. Participants navigated two routes in a counterbalanced sequence: one route included a parking search task, while the other served as a baseline. Vehicle instrumentation recorded speed and lane location, physiological sensors monitored heart rate and galvanic skin reaction, and a head-mounted eye-tracker captured gaze position. Participants administered the NASA Task Load Index after each tour. Participants exhibited reduced speed and proximity to the curb when seeking for parking, resulting in an increased perception of effort. Although no statistically significant effects were seen in physiological parameters, there was an increase in heart rate nearing statistical significance. An in-depth study of eye-tracking data indicated a significant change in gaze behaviour during parking searches, characterised by an increase in prolonged off-road looks (>2 s) and a reduction in brief off-road glances (<1.6 s). Certain demonstrated behaviours, such as deceleration, may serve to mitigate the adverse impacts of heightened demands related to parking searches, whilst others, such prolonged off-road looks, might elevate the likelihood of collisions. This research serves as a crucial first step in elucidating alterations in driving performance, physiological responses, and gaze behaviour induced by the search for parking in a real-world urban context.

Greibe's (2003) modelling study revealed that both driving and road width were important predictors of accident rates on road linkages, with parking's contribution to higher collision rates being more than that of roadway width. This indicates that elements beyond road width must contribute to the increased collision risk associated with on-street parking. In intricate urban settings, drivers must observe the motions of both humans and automobiles. Stationary vehicles may impede visibility of the roadway, complicating the observation of crossing pedestrians. Stationary vehicles may abruptly transition to moving vehicles and re-enter the flow of traffic. Research indicates that the presence of moving cars in a scene adversely impacts awareness of the situation and hazard avoidance (Gugerty, 1997), whereas stationary vehicles may exacerbate this issue, since they need observation to ascertain their motion status. The presence of parked vehicles thereby heightens ambiguity, cognitive burden, and possible hazards within the roadway context.

2.3 Summary of Literature Review

This present research reviewed studies on the relationship between traffic light and traffic congestion, the relationship between traffic accidents and traffic lights as well as studies relating to unguided roadside parking and traffic light by different authors, scholars and researchers in Nigeria and outside Nigeria. To the best of my knowledge, in the course of the literature review, there is no study that investigate the digitalization of traffic management in Nigeria: an assessment of the traffic light in Calabar Metropolis, Cross River State. Based on this, the present study attempts to fill this research gap.

2.4 Theoretical Framework

Modernization Theory

Modernisation theory is employed to elucidate the process of modernisation within societies. Traditional societies are expected to evolve as they adapt more contemporary practices, according to modernisation theory. Modernisation is either essential or at least preferred to the status quo due to advancements in data technology and the necessity of updating conventional processes in transport, communication, and production. Rostow (1971) observed that societies will become more highly developed through increased investment, increased exposure to modernised western society, as well as modifications in traditional culture and values, while the theory examines the internal factors of a country and assumes that with assistance, "traditional" countries can be that are brought to development in the same manner as more developed countries had been.

Modernisation theory endeavours to both identify the social variables that contribute to the social progress and development of societies and to elucidate the process of social evolution. Modernisation theory posits that the progression of societies follows a singular trajectory, thereby dividing all nations into Western and non-Western cultures.

It investigates a variety of internal factors, including the implementation of innovative technologies and social and cultural structures. This theory posits that the absence of digitisation is the root cause of underdevelopment in countries and that advancement for these nations can only be made by increasing their prosperity, which is contingent upon their availability of technology, education, entrepreneurial freedom, and free trade.

The relevance of this theory to this study is that the Cross River State government has implemented the deployment of digitalised traffic lights at strategic locations to address the traffic challenges within Calabar Metropolis and mitigate their negative effects. This approach aims to reduce traffic congestion, traffic-related clashes, and unguided roadside parking of vehicles.

3. Methodology

This research used a survey methodology to evaluate the digitalisation of traffic management in Nigeria, specifically assessing the traffic lights in Calabar Metropolis, Cross River State. The subject of investigation is Cross River State. Cross River. The study population consists of the whole adult demographic of Calabar South and Calabar

Municipality Local Government Areas. The 2006 National Population Census indicates that the two Local Government Areas have a combined population of 321,022, which is the population for this research. This research utilises stratified sampling, quota sampling, and accidental sampling methodologies. The stratified sample method improves the division of the research population into driver and passengers. The quota approach allowed for an equal distribution of respondents, with 150 assigned to Calabar South and 150 to Calabar Municipality, while the incidental sampling technique facilitated the researcher in administering questionnaires to two accessible individuals. The study's sample size is 210, representing 70 percent of the total population. The primary tool for data collection was a questionnaire, which was designed with a five-point Likert Scale including Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. The data for this investigation was ultimately analysed using the chi-square statistical method.

4. Data Presentation, Analysis and Discussion of Findings

Table 4.1:
Summary of respondents

Questionnaire	Responses	Total	Percentage (%)
No. returned	200	200	95.2
Not returned	10	10	4.8
Total	210	210	100

Source: Field survey by the Author, 2024

Table 4.1 indicates that respondents were administered two hundred and ten (210) questionnaires. Of these, 200 questionnaires were returned, while 10 questionnaires were not returned. The total number of questionnaires returned was 200, which represents 95.2% of the respondents. The total number of questionnaires that were not returned was 10, which represents 4.8% of those who responded who never returned their questionnaire.

4.2 Test of Hypotheses

Hypothesis One

Ho1: The installation of digitized traffic lights have not significantly helped to ease long vehicular queues among motorists in Calabar Metropolis.

Figure 4.1

Summary of Chi-square computation to show if the installation of digitized traffic lights have significantly helped to ease long vehicular queues among motorists in Calabar Metropolis.

Test Statistics

	Installation of digitized traffic lights and long vehicular queues among motorists in Calabar Metropolis.
Chi-Square	22.493[a]
Df	14

Asymp. Sig.	.117

Source: Researcher's computation, 2024.

From figure 4.1 above, it can be observed that since the chi-square calculated value of 22.493 is less than the table value of 23.68 at 14 degree of freedom and the p-value of 0.117 is greater than 0.05 chosen significance level. We therefore accept the null hypothesis which states that the installation of digitized traffic lights have not significantly helped to ease long vehicular queues among motorists in Calabar Metropolis. This result implies that installation of digitized traffic lights has not contributed in reducing long vehicular queues among motorists in Calabar Metropolis.

Hypothesis Two
HO2: 2.Traffic congestion related clashes among motorists have not significantly reduced due to the installation of digitized traffic lights in Calabar Metropolis.

Figure 4.2
Summary of Chi-square computation to show if traffic congestion related clashes have significantly reduced due to the installation of digitized traffic lights in Calabar Metropolis.

Test Statistics

	Traffic congestion related clashes among motorists and installation of digitized traffic lights in Calabar Metropolis.
Chi-Square	205.611[a]
Df	12
Asymp. Sig.	.000

Source: Researcher's computation, 2024.

Figure 4.2 indicates that the estimated chi-square value of 205.611 exceeds the table value of 21.03 at 12 degrees of freedom, and the p-value of 0.000 is larger than the selected significance threshold of 0.05.
Consequently, we reject the null hypothesis asserting that traffic congestion-related conflicts among drivers have not significantly diminished due to the implementation of digitised intersections in Calabar Metropolis, and we conclude that such conflicts have indeed significantly reduced as a result of this installation. This result indicates that the implementation of digitised traffic signals in Calabar Municipality has greatly decreased traffic congestion-related conflicts among motorists.

Hypothesis Three

HO3: Unguided roadside parkings of vehicles by motorists have not been significantly regulated due to the installation of traffic lights in Calabar Metropolis.

Figure 4.3
Summary of Chi-square computation to show if unguided roadside parkings of vehicles have been significantly regulated due to the installation of traffic lights in Calabar Metropolis.

Test Statistics

	Unguided roadside parkings of vehicles by motorists and the installation of traffic lights in Calabar Metropolis.
Chi-Square	24.014[a]
Df	15
Asymp. Sig.	.104

Source: Researcher's computation, 2024

The chi-square computed value of 24.014 is less compared to the table value of 25.00 at 15 degrees of freedom, and the p-value of 0.104 is greater than the 0.05 chosen significance level, as shown in figure 4.3 above. We therefore adopt the null hypothesis, which posits that the implementation of traffic signals in Calabar Metropolis has not substantially regulated the unguided roadside parking of vehicles by motorists.

Discussions of Findings

From the results, the installation of digitized traffic lights have not significantly helped to ease long vehicular queues in Calabar Metropolis. This finding could be as a result of insufficient digitized traffic lights in Calabar Metropolis to help curb long vehicular queues. It could also be as a result of faulty digitized traffic lights that are not functioning in Calabar Metropolis. Furthermore, it could be as a result of no installation of digitized traffic lights in Calabar South Local Government Area. This finding is not consistent with the findings of Aleko and Djabal (2020), Nabila, Salah and Maroloud (2019) who all suggested that digitized traffic lights could help to control long vehicular queues.

Furthermore, from the results, Traffic congestion related clashes have significantly reduced due to the installation of digitized traffic lights in Calabar Metropolis. This result may be as a result of the presence of road enforcement officers on major roads in Calabar Metropolis that have gone a long way to reduce traffic congestion related clashes significantly. It could also be due to the setting up of speed bumps on major roads in Calabar Metropolis which helps to slow motor – vehicle traffic in order to improve safety conditions and traffic congestion related clashes in Calabar Metropolis.

Finally, from the results, unguided roadside parkings of vehicles have not been significantly regulated due to the installation of traffic lights in Calabar Metropolis. This finding could be as a result of insufficient digitized traffic lights in Calabar Metropolis to help curb unguided roadside parkings. It could also be as a result of faulty digitized traffic lights that are not functioning in both Calabar South and Calabar Municipality. Furthermore, it could be as a result of lack of digitized traffic lights in Calabar South Local Government Area.

5. Conclusion and Policy Recommendations

Traffic management is of utmost important in our cities due to the problem of congestion of road traffic. Hence, this study examines the digitalization of traffic management in Nigeria: an assessment of the traffic light in Calabar Metropolis, Cross River State. From the findings of the study, it is concluded that that the installation of digitized traffic lights have not significantly helped to ease long vehicular queues in Calabar Metropolis, Traffic congestion related clashes have significantly reduced due to the installation of digitized traffic lights in Calabar Metropolis and unguided roadside parkings of vehicles have not been significantly regulated due to the installation of traffic lights in Calabar Metropolis..

Based on these research findings, the following recommendations are made:

i. The State government should install adequate digitized traffic lights in Calabar Metropolis to help curb long vehicular queues.

ii. The authorities concern should replace faulty digitized traffic lights that are not functioning in Calabar Metropolis so as to assists in curbing traffic congestion related clashes, long vehicular queues and unguided roadside parkings.

iii. The State government should ensure that adequate digitized traffic lightsare installed in Calabar South Local Government Area to help control traffic congestion related clashes, long vehicular queues and unguided roadside parkings.

References

Aleko, D., R. & Djahel, S. (2020). " An Efficient Adaptive Traffic Light Control System for Urban Road Traffic Congestion Reduction in Smart Cities". *Information*, 11(2), 119, 2020. https://doi.org/10.3390/info11020119

Ali, W., Brek, A. & Bouakkez, F. (2023). Traffic Management system and Traffic Light Control in Smart City to Reduce Traffic Congestion. *International Journal of Automation and Smart Technology*, 13(1), 1 – 10.

Bakhtari et al (2022).. Drivers' Unsafe Behaviors in Iran: An Investigation in West Azerbaijan. Front. Public Health 2022, 10, 815380.

Biswas, S., Chandra, S. & Ghosh, I. (2017). Effects of On-Street Parking in Urban Context: A Critical Review. Transp. in Dev. Econ, 3(10), 1 – 14.

Cao, Y., Yang, Z., Z., & Zuo, Z., Y. (2017) The effect of curb parking on road capacity and traffic safety. Eur Transp Res Rev 9(4), 1–10. doi:10.1007/s12544-016-0219-3

Catalina Ortega, et al (2021). Effects of Mobile Phone Use on Driving Performance: An Experimental Study ofWorkload and Traffic Violations. *Int. J. Environ. Res. Public Health* 2021, 18, 7101. [CrossRef]

Charlton, S., G. & Baas, P., H. (2006) Speed change management for New Zealand roads

Chiguma, M., L., M, & Bang, K. (2007) Impact of individual side friction factors on free-flow speed: case study on urban road links in Dar-es-Salaam, Tanzania. 86th Annu. Meet. Transp. Res. Board (CD-ROM), Natl. Acad. Washingt. D.C.

De Cerreño, A. (2004) Dynamics of on-street parking in large central cities. Transp Res Rec J Transp Res Board 1898:130– 137. doi:10.3141/1898-16

Edquist, J., Rudin-Brown, C., M. & Lenné, M. G. (2012) The effects of on-street parking and road environment visual complexity on travel speed and reaction time. Accid Anal Prev 45:759–765. doi:10.1016/j.aap.2011.10.001

Gårder, P., Ivan, J., N. & Du, J. (2002) Traffic Calming of State Highways: Application New England. Technical Report, Project No. UCNR13-5, New England University Transportation Center, Massachusetts Institute of Technology

Gjorgjievski,, M., Khanna, V., Petrisor, B., Li, C .S. & Ristevski, B. (2021). Roadside Evaluation of Distracted Driving—Driver Limitations in Recognizing Traffic Light Transitions (REDD—LIGHT). *J. Transp. Health* 2021, 21, 101059.

Gitelman, V., Balasha, D.,& Carmel, R. (2012) Characterization of pedestrian accidents and an examination of infrastructure measures to improve pedestrian safety in Israel. Accid Anal Prev 44:63–73. doi:10.1016/j.aap.2010.11.017

Huth, V., Sanchez, Y. & Brusque, C. (2015). Drivers' Phone Use at Red Traffic Lights: A Roadside Observation Study Comparing Calls and Visual–Manual Interactions. *Accid. Anal. Prev*. 74, 42–48

Hyunjin, J., Syed, S. A., & Yujin, L. (2020)" Traffic signal control for smart cities using reinforcement learning" Computer Communications, Vol. 154, pp. 324–330, 2020. https://doi.org/10.1016/j.comcom.2020.03.005

Jensen, S. U, (2007). Rosenkilde C, Jensen N (2007) Road safety and perceived risk of cycle facilities in Copenhagen. Trafites Copenhagen, Denmark 1–9

Joo, H., Ahmed, S. H. & Lim, Y. (2020)." Traffic signal control for smart cities using reinforcement learning", *Computer Communications,* Vol. 154, pp. 324– 330, 2020. https://doi.org/10.1016/j.comcom.2020.03.005

Kulkami, S. & Ade, R. (2017). "Intelligent Traffic Control System Implementation for Traffic Violation,Congestion Control and Stolen Vehicle Detection"Ijes, 5(2), 57-71.

Kurdi, H. A. (2014). Review of Closed Circuit Television (CCTV) Techniques for Vehicles Traffic Management,International Journal of Computer Science & Information Technology (IJCSIT) 6(2), April 2014.

Lee, W., H. & Chiu, C., Y. (2020). "Design and Implementation of a Smart Traffic Signal Control System for Smart City Applications", *Sensors*, 20920, 508, 2020. https://doi.org/10.3390/s20020508

Lerner-lam, E., Celniker, S., R, & Halbert, G., W.(1992) Neo-traditional neighborhood design and lis implications for traffic engineering. ITE J 62:17–25

Lim, M., A., Hallare, E., L.& Briones, J. G. (2012) Modeling the impact of on-street parking. 5th ATRANS Symp. Bangkok, Thail

Lokesh, S., & Prahald Reddy, T. (2014). An Adaptive Traffic Control SystemUsingRasspberry pi, 3(6): June, 2014

Munawar, A. (2011) Speed and capacity for urban roads, Indonesian experience. Procedia Soc Behav Sci 16:382–387

Nabila, B., Salah, Z., & Mawloud, O. (2019). "Context aware negotiation, reputation and priority traffic light management protocols for VANET based smart cities", Telecommun System, Vol. 72, pp. 131–153, 2019.https://doi.org/10.1007/s11235-019-00555-x

Ndiyo, N. A .(2005). Fundamentals of research in behavioural sciences and humanities.Wusen Publishers

Neelakandan, S., Berlin, M. A., & Tripathi, S. (2021). " IoT based traffic prediction and traffic signal control system for smart city", Soft Computing, Vol. 25, pp. 12241–12248, 2021. https://doi.org/10.1007/s00500-021-05896-x

Pandit, K., Ghosal, D., Zhang, H., M. & Chuah, C., N. (20130. " Adaptive traffic signal control with vehicular ad hoc networks", *IEEE Transactions on Vehicular Technology*, 62(4), 1459–1471, 2013.https://doi.org/10.1109/TVT.2013.2241460

Roopa, M. S., Ayesha,,B., Rajkumar., K. R., Venugopal, S. S., Iyengard, ,L. M.(2020). "Dynamic Management of Traffic Signals through Social IoT", Procedia Computer Science,Vol. 171, pp. 1908–1916, 2020.https://doi.org/10.1016/j.procs.2020.04.204

Salisu, U., Sadiku, L., U., & Tonga, D. A. (2019). Intelligent-Based Control System for

Effective Road Traffic Management in Nigeria: A Proposed Model. *International Journal of Latest Engineering Science (IJLES)*.02(06), 17 – 25.

Sharma, N., Advani, M., Dhyani, R., Nagar, S. & Chaudhary, H. (2022). Reduction in Idling Fuel Losses and Corresponding Emissions Due to Awareness Campaign at the Signalized Intersections in Delhi. *Transp. Dev. Econ.* 8(11).

Traffic Management Centre. (2014),[online].

Available:http://www.bangaloretrafficpolice.gov.in/index.phpoption=com=content&view=article &id=87&btp=87, accessed 2014.

Younes,M., B. & Boukerche, A. (2016)." Intelligent traffic light controlling algorithms using vehicular networks", *IEEE Transaction on Vehicular* Technology, 65(8), 5887–5899, 2016.https://doi.org/10.1109/TVT.2015.2472367

Younes ,B., Omar, B, Y., & Mohamed ,I., (2019). "Application model of tasks scheduling problem in distributed systems solving problems of road traffic planning in smart cities", *Third International Conference on Intelligent Computing in Data Sciences (ICDS)*, Marrakech, Morocco, October 28-30, 2019, pp. 1–7.

https://doi.org/10.1109/ICDS47004.2019.8942310

Zein, S., Geddes, E., Hemsing, S. & Johnson. M. (1997) Safety benefits of traffic calming. Transp Res Rec J Transp Res Board 1578:3– 10. doi:10.3141/1578-01