ROAD USERS' PERCEPTION ON THE FACTORS INHIBITING THE ADOPTION OF INTELLIGENT TRANSPORT SYSTEM IN MANAGING ROAD TRAFFIC PROBLEMS IN NIGER STATE

ABUBAKAR IBRAHIM DAMANA
Department of Transport Management, Ibrahim Badamasi Babangida University,
Lapai, Niger State, Nigeria.
ibrahimdamana2015@gmail.com +2347016983859

SOLOMON NDACE JIYA
Department of Geography, Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria.
solojiya@yahoo.com

BABA YUSUF NDAGI
Department of Transport Management, Ibrahim Badamasi Babangida University,
Lapai, Niger State, Nigeria.
babayusuf89@gmail.com

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Keywords

Adoption, Inhibition, Intelligent, Transport, System.

Abstract

Research Problem: *Urban centres worldwide, including major cities of Niger state, faces significant challenges in traffic management, resulting in congestion, accidents, and environmental pollution, causing threat to the wellbeing of its residence. Traditional traffic management methodshave proven insufficient, necessitating the possible adoption of innovative solutionto manage road traffic problems.*

Methods: *The research utilized questionnaire survey to collect primary data. 400 sample size were determined using Taro Yamanne's formula with apopulation of 36,828road users. Factor analysis was used to analyse the data collected.*

Results: *The findings of the Principal Component Analysis (PCA) revealed two major components. The first component hasan eigenvalue of 8.225, indicating a large portion of the variance in the data, which accounts for 82.225% of the total variance. Adds the second component, 1.332 (13.321%) bringing the cumulative explained variance to 95.572%. This suggests that the first and second principal component captures the vast majority of the factors from the original variables and only the first two components are significant enough to be retained. This two factors indicate inadequate government funding and lack of knowledge about ITS in Niger state.*

Conclusion: *In conclusion, the study's findings point to the need for an integrated approach to overcome the barriers related to ITS adoption in Niger state, focusing on resource mobilization, training, and partnership building.*
Key Contribution to Knowledge: *This research contributes to global discussions on urban mobility, particularly in regions with limited technological infrastructure and funding restrictions.*
Recommendation: *Major recommendation includes investing on ITS-compatible infrastructureby the government of Niger state, for effective traffic management.*

Introduction

Throughout the years, travel has provided numerous benefits to humanity, facilitating the movement of people and the delivery of finished goods across diverse geographical regions via various transport modalities. Road transport, specifically, has enabled travellers to reach desirable locations and serves as an essential feeder for all other transportation modes. As urban areas expand and develop, the road infrastructure experiences considerable strain (Garg and Kaur, 2023). This situation has led to various challenges in road transport, including traffic congestion, accidents, environmental degradation, and insecurity, all of which impose significant social and economic impacts on road users and the nation's Gross Domestic Product (GDP) (Mangla et al., 2023).

The economic consequences of congestion have been evaluated in multiple countries. In 2018, traffic congestion in the United States resulted in an estimated cost of $305 billion (Benjamin, 2018). The financial impact of delays in Cairo, Egypt, was calculated at $2,827,446,364. Road traffic congestion results in elevated CO2 emissions, increased fuel consumption, and unpredictable travel times. The escalating tendency of migration from rural areas to urban centres in Nigeria, driven by the quest for essential amenities, has led to a substantial rise in urban populations. The rapid urbanisation, coupled with the inadequacy of the public transport system to meet increasing demand, has resulted in heightened dependence on private vehicles (Garg and Kaur, 2023). This shift to private vehicles to fulfil mobility needs has caused traffic issues in Niger State. Consequently, there is an imperative need to develop and implement Intelligent Transport Systems (ITS) to address these traffic-related challenges. Intelligent Transport Systems (ITS) utilise advanced communication, computer, and information technology to enhance the safety and efficiency of transport networks (Patel et al., 2022). Osipitan (2014) observed that scholars have endorsed the implementation of ITS technology to address traffic challenges.

Nonetheless, Intelligent Transportation Systems can only substantially improve road user safety if users are amenable to its use. Larue et al. (2015) defined user acceptability as the willingness of a prospective user to engage with a specific system (Nkoro and Vershinin, 2014). Prior investigations by Toulouki et al. (2017), Vencataya et al. (2018), Ajayi et al. (2021), Neverauskienė et al. (2021), Olasupo et al. (2021), and Adeleke et al. (2016) concentrated on clarifying the various uses of ITS, as well as its advantages and obstacles. The studied literature reveals a deficiency in comprehending human attitudes concerning the implementation of Intelligent Transportation Systems (ITS). Human perceptions are a vital factor that must be acknowledged when deploying technology such as ITS (Kołodziej et al., 2022). This study investigates road users' perspectives of

the reasons hindering the use of Intelligent Transportation Systems (ITS) in mitigating road traffic problems in Niger State.

Statement of the problem

Global urban centres, including the major cities of Niger State, have significant issues in traffic management, leading to congestion, accidents, and environmental pollution, which jeopardise the well-being of citizens in metropolitan areas. Traditional traffic management methods, like the use of traffic wardens and conventional signals, have proven insufficient, underscoring the necessity for the future adoption of novel technologies such as Intelligent Transport Systems (ITS) to tackle road traffic challenges. The efficacy of modern technologies, especially in Niger state, relies not only on their technological viability but also on user perceptions, trust, and acceptability. If road users possess misconceptions or lack a comprehensive grasp of ITS, the implementation of these systems may face considerable challenges, and their benefits may remain unexploited.

Research objectives

This research aims to achieve the following objectives:

To examine road users' perceptions of the socio-economic, infrastructural, and institutional factors inhibiting the adoption of Intelligent Transport Systems (ITS) in managing road traffic problems in Niger State.

To analyse the extent to which road users' awareness, attitudes, and willingness to accept ITS influence the perceived barriers to ITS adoption in Niger State.

2.0 Review of the Relevant Literature

Conceptual Framework

The Intelligent Transport System (ITS) comprises a wide range of technology and applications aimed at addressing multiple transport concerns. Commonly known as smart transport, Intelligent Transport Systems (ITS) have been a prominent concept for tackling transport challenges since the 1990s, with many academic academics and industry professionals concentrating on improving the efficiency of transport operations (Mitchel, 2012; Salisu et al., 2020). Salisu et al. (2022) contend that the Intelligent Transportation Systems (ITS) concept has achieved extensive endorsement and has demonstrated benefits in the administration of road traffic systems, especially in real-time traveler information management; road pricing or usage fees; smart charging for electric vehicles; vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) system oversight; as well as centralised urban management and logistics, among various other applications.

Mujakachi et al. (2023) emphasise that the term ITS encompasses a wide array of wireless and wired information, communication, and electronic technologies integrated into road infrastructure and vehicles to alleviate traffic congestion, improve road safety, increase productivity, reduce travel time, and decrease overall transportation costs. The Federal Highway Administration (2022) asserts that Intelligent Transport Systems (ITS) in traffic management employ sophisticated technologies to enhance the efficiency, safety, and sustainability of road networks. Through the integration of information and communication technology, sensors, and data analytics, Intelligent Transportation Systems (ITS) seeks to enhance traffic flow, mitigate congestion, and decrease the frequency of accidents.

Dewangan et al. (2017) defined the Intelligent Transport System (ITS) as the implementation of diverse advanced technologies designed to improve traffic safety via the use of Closed Circuit Television (CCTV) cameras connected to a central monitoring system for the surveillance of various segments of the road

network, public transit vehicles, and terminal stations.

Components of ITS

Intelligent Transport Systems (ITS) in traffic management consist of five fundamental components, outlined as follows:

Information and Communication Technologies: Information and Communication Technologies (ICT) form the cornerstone of Intelligent Transportation Systems (ITS), delivering essential data and analytics that enhance decision-making processes. This encompasses wireless communication technologies, data analytics platforms, and mobile applications developed for traffic information and navigation (Mangiaracina et al., 2017). Wireless communication systems, including cellular networks and dedicated short-range communications (DSRC), provide real-time interactions between vehicles and infrastructure, hence enhancing Intelligent Transportation System (ITS) applications like as traffic light management and collision prevention (Bertini, 2020).

Sensors and surveillance systems: Sensors and Monitoring Systems are crucial for the real-time assessment of traffic conditions, utilising devices such as traffic cameras, radar sensors, and inductive loop detectors. Traffic cameras, including Closed Circuit Television (CCTV) and Automatic License Plate Recognition (ALPR), are essential for monitoring traffic conditions and detecting events (Miller et al., 2021). These cameras provide real-time video information, enabling traffic operators to promptly respond to accidents, congestion, and other incidents. ALNP cameras specifically offer functionalities for license plate identification, hence improving traffic monitoring and enforcement (Javed et al., 2016).

Automation and control systems are engineered to optimise traffic operations, hence guaranteeing a secure and efficient traffic flow. This encompasses systems like automated traffic signal control, ramp metering, and dynamic lane management (Malygin et al., 2018). Automated traffic signal management systems improve traffic flow by adjusting signal timings in real-time, hence reducing congestion and decreasing travel times (Drop and Garlińska, 2021). These systems depend on data gathered from sensors and cameras to evaluate traffic conditions, thus facilitating efficient traffic signal administration. Moreover, sophisticated algorithms, especially those utilising machine learning methodologies, markedly enhance the efficacy of automated traffic signal control systems (Chen et al., 2020).

Data management and integration are essential elements in the domain of traffic data processing. Data warehouses and databases are crucial for the storing and management of large traffic datasets, which are necessary for real-time analytics and informed decision-making (Okoroafor et al., 2019). These data archives facilitate data-driven transportation management, providing critical insights into traffic patterns, congestion levels, and incidents inside metropolitan settings. Data integration solutions, such as the Federal Road Safety Corps' data fusion platform, facilitate the consolidation of information from many sources, including sensors, cameras, and social media, thereby offering a comprehensive perspective on traffic conditions (Adebayo et al., 2020). \

Interface and dissemination: Variable message signs (VMS) and dynamic message signs (DMS) are essential for delivering real-time traffic information to drivers. These signs provide critical information, including traffic congestion, accidents, and road closures, enabling drivers to make informed decisions. Studies demonstrate that VMS and DMS

facilitate decreased congestion, abbreviated trip times, and improved overall traffic safety (Taylor et al., 2019). Mobile applications for traffic information, such as the TrafficPal app developed by Emily Chen, provide customised traffic updates to users (Anderson et al., 2019). These programs employ real-time data from several sources, including sensors, cameras, and social media, to deliver accurate traffic statistics. Research indicates that mobile applications can reduce journey durations, mitigate stress, and improve the overall user experience (Wilson et al., 2019).

Benefits of ITS in TrafficManagement

The deployment of Intelligent Transport Systems (ITS) in traffic management has numerous benefits, beginning with improved safety. Automated control systems and real-time monitoring are crucial in substantially diminishing the probability of accidents and incidents, therefore enhancing the safety of all road users (Nguyen et al., 2022). The escalation of road traffic is associated with a growth in road accidents, which provide a significant threat to individual safety. The implementation of Intelligent Transportation Systems (ITS) can reduce accidents, hence protecting lives and property by providing precise information and direction to drivers (Naga et al., 2014). This improvement in safety is additionally reinforced by sophisticated warning systems and emergency response tactics that safeguard road users. Davis et al. (2022).

The deployment of Intelligent Transport Systems (ITS) in traffic management markedly enhances efficiency across multiple operating sectors. Real-time traffic monitoring systems promote efficient traffic flow, reduce congestion, and improve travel times (Johnson et al., 2023). Advanced routing and scheduling technology ensure that drivers adhere to ideal routes, hence reducing delays and diminishing the need for manual interventions (Dewangan et al., 2017). The state of road traffic is deteriorating daily due to the persistent increase in transportation demand. The continuous honking of vehicles and the resultant carbon emissions can negatively impact both individuals and the environment. The Intelligent Transport System (ITS) is essential for improving road user safety, regulating traffic at crowded intersections, and facilitating trip-related decision-making. This effectively results in diminished environmental pollution, notably a reduction in CO2 emissions, while concurrently enhancing the general safety and efficiency for all road users (Alonso et al., 2022).

Empirical Review

The body of literature on intelligent transport systems in mitigating transport issues is substantial. Dukiya (2013) examined energy shortages, climate change, and the obstacles to implementing Intelligent Transport Systems (ITS) in African countries. The research assessed the adherence of the Federal Road Safety Corps (FRSC) and police operations to Intelligent Transportation Systems (ITS) in Abuja and Minna. The results indicated an absence of contemporary ITS infrastructure, with roughly 65% of road signalling equipment either inoperative or malfunctioning as a result of power failures. The study stated that African nations, including Nigeria, necessitate adequate financial planning and personnel development to enable successful ITS deployment.

Tomaszewska (2021) examines the challenges related to the deployment of Intelligent Transport Systems (ITS) in Polish urban areas. The study delineates these obstacles from the viewpoint of personnel tasked with urban transport organisation, representing the local government of certain cities in Poland. The author utilises qualitative methods to examine the data. The findings reveal that the principal obstacles to ITS deployment encompass

economic, social, organisational, technological, and legal problems.

Mujakachi et al. (2022) investigate the determinants affecting the adoption and execution of Intelligent Transportation Systems in Harare, Zimbabwe. Their findings underscore two critical obstacles that impede the successful adoption and implementation of ITS in Harare. The primary difficulty is inadequate governmental support for financing the building and development of the system, while the secondary challenge is the poor comprehension of the idea of Intelligent Transportation Systems (ITS) and its appropriate implementation. The aforementioned considerations have resulted in significant challenges in the adoption and deployment of Intelligent Transportation Systems in various developing nations. Chukwurah et al. (2018) performed a survey regarding the implementation of Intelligent Transportation Systems to mitigate traffic problems in Enugu, Nigeria. Their study assessed the function of Intelligent Transport Systems in alleviating traffic congestion by examining the existing traffic management system in Enugu Urban and evaluating the possibility for a more efficient traffic management system utilising intelligent transport systems.
A multitude of studies has investigated the literature pertinent to this research, focussing on the implementation, benefits, challenges, and prospects for the adoption of intelligent transport systems to mitigate traffic problems (Dukiya, 2013; Tomaszewska, 2021; and Chukwurah et al., 2018). The examined literature reveals a deficiency in comprehending road users' perceptions concerning the assessment of issues that impede the use of ITS technology. This study has filled this gap by examining road users' perspectives of the reasons hindering the adoption and deployment of Intelligent Transportation Systems (ITS) in addressing traffic issues in Niger State.

3.0 Research Methodology

Study area

Niger State is located roughly between latitudes 8° and 11° North and longitudes 3° and 7° East. The state covers approximately 76,363 square kilometres and is bordered by Kaduna State and the Federal Capital Territory (FCT) to the east and southeast, respectively; Kebbi State and Zamfara State to the north; Kwara and Kogi States to the south; and the international boundary with the Republic of Benin to the west. Minna Metropolis consists of two local government council areas: Bosso and Chanchaga. It accommodates various educational establishments, such as the Niger State College of Education (COE) Minna, the Federal University of Technology (FUT) Minna, in addition to the Bola Ahmed Tinubu International Airport situated in Maikunkele and the Minna railway station. Niger State hosts JAAF Foods Nigeria Limited and other logistics firms, including DHL Nigeria, FedEx Nigeria, and the Nigerian Postal Services (NIPOST). Kontagora hosts the Federal University of Education and the School of Nursing and Midwifery, whilst Bida is the location of the Federal Polytechnic Bida. Figure 1 depicts the maps of Niger State within the national framework (a), the administrative divisions of Minna Metropolis (b), and the road infrastructure in Minna Metropolis.

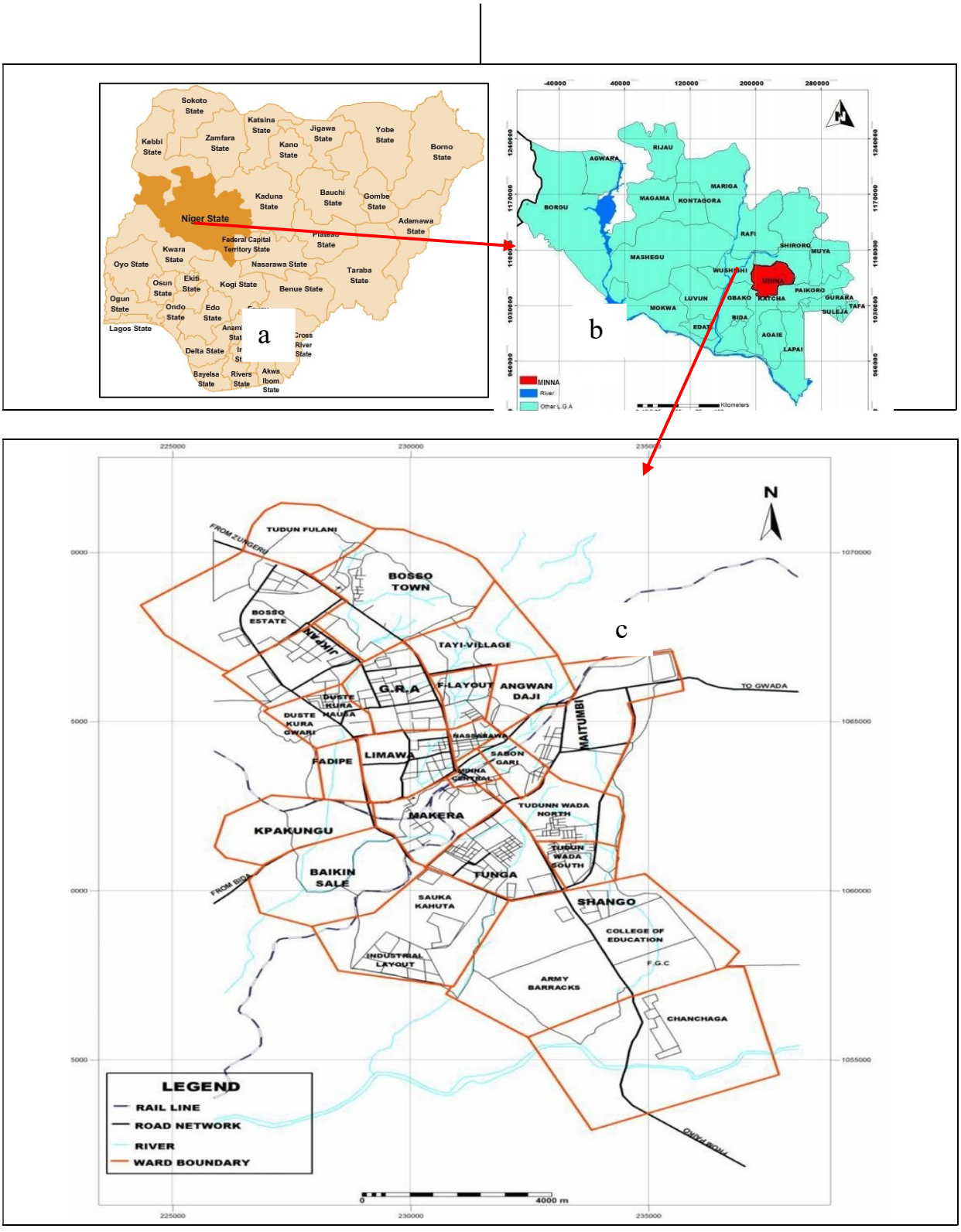


Figure Error! No text of specified style in document. **Niger State in the national context (a), administrative partitioning of Minna Metropolis (b) and the road connectivity of Minna Metropolis (c).**

Source: Department of Transport Management, FUT, Minna (a, b and c).

Population of the study

The research population comprises road users from the four principal cities of Niger State: Minna, Suleja, Bida, and Kontagora. This includes drivers, passengers, tricyclists, and motorcyclists. This study involved conducting a survey at designated motor parks and commercial centres over a 10-day period (Monday to Friday) to estimate the population of road users in Niger State. The study area comprises four principal cities. These cities were arbitrarily chosen to exemplify the demographic of road users in Niger State. The selection was predicated on the commercial activities and traffic density of these regions. A total of 36,828 road users were collected from diverse transport unions, as indicated in Table 1. The transport unions comprise the National Union of Road Transport Workers (NURTW), the National Association of Road Transport Owners (NARTO), and the Amalgamated Commercial, Tricycle, Repairers, and Riders Association of Nigeria (ACCOMORA).

Table1 Road users' population and frequency across selected clusters

City/Road users	Drivers	Passengers	Tricyclists	Motorcyclists	Total	Frequency (%)
Minna	2,613(23%)	4,863(44%)	2,140 (19%)	1,538(14%)	11,154	30
Suleja	2,705(22%)	4,678(37%)	2,067(17%)	2,966(24%)	12,416	34
Bida	1,671(23%)	2,556(35%)	876(12%)	2,229(30%)	7,332	20
Kontagora	1,167(20%)	2,460(42%)	258(4%)	2,041(34%)	5,926	16
Total	8,156	14,557	5,341	8,774	36,828	100

Source: Survey (2025).

Table 1 presents the population of various groups of road users in four prominent cities of Niger State. Each city illustrates the ratio of the population among each group of road users, as well as the frequency of population distribution. The survey projected a total population of 36,828. Consequently, the overall population size (N) for this investigation comprised 36,828 road users.

Sample and Sampling Technique

The selection of sample respondents was through a stratified sampling technique. The stratified sampling technique was adopted in the administration of the questionnaires. However, the questionnaire was randomly administered to various categories of road users across the four major cities of Niger State. The following Taro Yamane's formula was adopted to determine the sample size.

$$n = \frac{N}{1} + n(e)^2$$ (Yamane, 1973). Equation 3.1

Where;

n =sample size

N= population size

e= level of significance = 0.05 confidence level

Hence;

$n = \frac{36828}{1+36828(0.05)2} = \frac{36828}{1+36828(0.0025)} = \frac{36828}{92.07} =$ 400

Therefore, the sample size (n) for this study = 400. However, 400 copies of the questionnaires were distributed to the respondents across the major cities, having in mind that the population size is 36,828. Table 2 shows the sample size distribution and percentage frequency across different categories of road users within the four major cities.

Table2 Sample size distribution

S/N	Cities/Road users	Drivers (*n*)	Passengers (*n*)	Tricyclists (*n*)	Motorcyclists (*n*)	Population (N)	Sample size(*n*)
1	Minna	29	53	22	17	11,154	121
2	Suleja	29	51	23	32	12,416	135
3	Bida	18	28	10	24	7,332	80
4	Kontagora	13	26	3	22	5,926	64
	Total					36,828	400

Source: Survey (2025).

From Table 2, each city represents the proportion and frequency of the sample size. A total of 400 sample size was determined using Taro Yamanne's formula.

Method of Data Collection/Instrumentation

To obtain the views of the road users, a paper-and-pencil questionnaire was designed and administered to drivers, passengers, motorcyclists and tricyclists. The data obtained from the survey was processed and analysed using statistical techniques to assess whether the road users' perception of the factors inhibiting the adoption of ITS will facilitate the management of road traffic problems in Niger State. Table3 shows the distribution of questionnaires administered and the retrieved responses from the four major cities of Niger State.

Table Error! No text of specified style in document. **Retrieved responses**

S/N	Clusters/Road users	Population (N)	Questionnaires administered	Retrieved responses
1	Minna	11,154	121	98
2	Suleja	12,416	135	102
3	Bida	7,332	80	72
4	Kontagora	5,926	64	57
	Total	36,828	400	329

Source: Survey (2025).

From Table 3, a total of 329 responses were retrieved, which constitutes a total of 82 per cent of the respondents.The instrument adopted was a four-point Likert scale with responses ranging from 4 "strongly agree" 3 "Agree"2"Strongly disagree" and1 "Disagree". Respondents were barred from interacting with other respondents while filling out the questionnaires.

Method of Data Analysis

In order to achieve the data analysis, factor analysis was used.The data was analysed using Statistical Package for the Social Sciences (SPSS).

4.0 Results

The Total Variance Explained in Table 4 presents the results of a Principal Component Analysis (PCA) for the dataset, detailing how much variance each component explains in the data.

Table 4 Total variance explained

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.225	82.251	82.251	8.225	82.251	82.251
2	1.332	13.321	95.572	1.332	13.321	95.572
3	.161	1.607	97.179			
4	.094	.939	98.117			
5	.055	.545	98.663			
6	.048	.484	99.147			
7	.042	.419	99.565			
8	.022	.216	99.782			
9	.017	.166	99.947			
10	.005	.053	100.000			

Extraction Method: Principal Component Analysis (PCA).
Source: Data computation (2025).

The initial eigenvalues in Table 4 indicate the entire variance accounted for by each component. The eigenvalue for the first component is 8.225, signifying a substantial proportion of the variation in the data. It accounts for 82.225% of the overall variance in the data. Incorporates the second component, 1.332 (13.321%), elevating the cumulative explained variance to 95.572%. This indicates that the first and second principle components account for the majority of the variance in the original variables, with just these two components being sufficiently significant to retain.
The residual components account for minimal variance, suggesting they lack significance in conveying further important information. These components may be regarded as noise or superfluous variables following the initial two components. The third component accounts for 1.607% of the variation, whereas the fourth component accounts for 0.939%. In the final component (10th component), the explained variance becomes minimal (merely 0.053%). Figure 2 displays the scree plot, frequently utilised in factor analysis or principal component analysis (PCA) to ascertain the ideal number of components to preserve in a dataset.

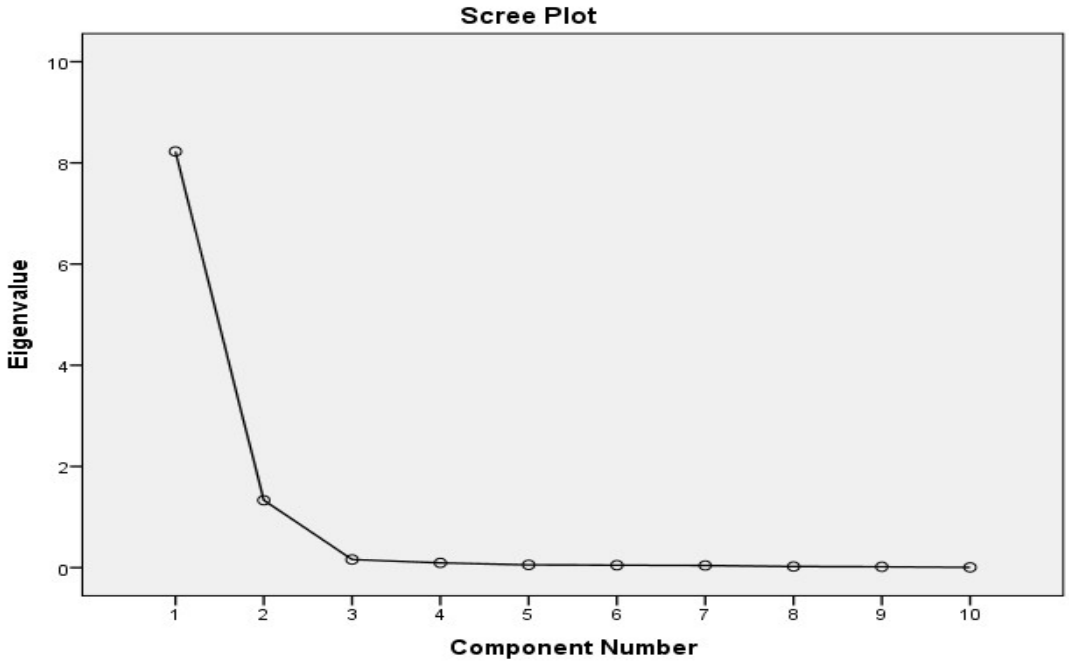


Figure 2 Factors inhibiting the adoption of ITS in Niger state
Source: Data computation (2025).

Figure 2 illustrates that the component number (X-axis) denotes the quantity of extracted components, but the eigenvalue (Y-axis) signifies the eigenvalues associated with each component. Eigenvalues signify the extent of variance elucidated by a specific component within the dataset. The plot commences with a substantial eigenvalue (8.225) for the first component, which diminishes significantly for the second component (1.332). Beyond a specific threshold (about the third component), the eigenvalues stabilise and create a "elbow," signifying declining rewards for the inclusion of further components. The initial two components (Component 1 and Component 2) had markedly elevated eigenvalues, signifying that these components account for the predominant portion of the variance within the dataset.

5.0 Conclusion and Recommendations

The primary obstacles to ITS deployment, as indicated in Table 4, encompass insufficient financing and a lack of expertise regarding ITS. This aligns with the research undertaken by Tomaszewska (2021), Mujakachi et al. (2023), and Dukiya (2013). The study's findings indicated that the primary factors obstructing the implementation of Intelligent Transportation Systems (ITS) in addressing road traffic issues are insufficient governmental financial support for system construction and development, as well as a deficiency in knowledge regarding ITS. These concerns indicate systemic problems, including fiscal limitations and inadequate cooperation among parties. This underscores the necessity for a cohesive strategy to address the adoption issues in Niger State. The study's results indicate the necessity for a comprehensive and multifaceted strategy to address these challenges, emphasising resource mobilisation, training, and relationship development.

The government and private sectors are advised to invest in and develop critical Intelligent Transportation System (ITS) infrastructure, including intelligent traffic signals equipped with sensors for traffic density detection and an Automatic License

Plate Recognition (ALPR) system for efficient traffic control and management.

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