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ASSESSMENT OF SPATIOTEMPORAL VARIATION IN INTER-STATE PASSENGER FLOW FROM KATSINA, KATSINA STATE, NIGERIA

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ABSTRACT

This paper examines the nature, pattern, and spatiotemporal variation of inter-state passenger movement from Katsina to other states nationwide. Two major terminals were purposively selected for the study: the Nigerian Union of Road Transport Workers (NURTW) and the Katsina State Transport Authority (KTSTA). Questionnaires were systemically administered to departing passengers. Information on passenger flow was collected from the passenger register at the motor parks. A flow line map was used to show the direction of the flow while a bar graph was used to show the volume or magnitude and temporal variation of passenger movement from Katsina to other states across the country. The findings reveal that the majority of the passengers were males who were married and most of them were traders and civil servants, thus, work- or business-related trips account for most of the reasons for traveling. The findings reveal that the NURTW terminal has a wider spatial coverage of 11 states while the KTSTA terminal has a spatial coverage of 9 States. Kano State is the most popular destination followed by Kaduna and Abuja. Generally, the findings show a seasonal pattern of passenger flow with higher numbers in the later months of the year (October to December) and lower numbers in the middle of the year (June and July). Recommendations include the enhancement of transport infrastructures to cater to work or business-related trips, seasonal adjustment, passenger demographic consideration, and promotion of off-peak travel. This is to ensure a more efficient and responsive transport system that meets the needs of travelers and maximizes customer satisfaction.

1. INTRODUCTION

The operation of an economy unequivocally necessitates transportation. As economies advance, specialized production emerges in diverse regions, necessitating various transportation modalities to facilitate the daily execution of social and economic activities in villages, towns, and cities globally. The number one function of transportation is facilitating the movement of humans and items and offering access to land use activities positioned in the service area (Levinson and Lomax, 2015). Transportation systems serve as a primary interface between the placement of activities and the general mobility of people in both developed and developing countries' urban systems (Kingham et al, 2015). Transportation, according to Tunde and Adeniyi (2012), enhances the functionality of the manufacturing sector, retail, labor, and housing sectors by facilitating better access to geographical and economic areas Road transport is the principal mode of transportation in Nigeria, accounting for the vast majority of freight and passenger travel. In the words of Onokala (2015), road transport significantly and decisively contributes to Nigeria's socio-economic development by facilitating the expansion of agricultural, industrial, and residential areas. Roads help to

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connect urban and rural communities and facilitate long-distance trade. Interregional trade fosters internal cohesion, satisfies the complementary nutritional requirements of Nigerians, and elevates the economic status of traders involved in long-distance commerce.

The transportation literature typically designates long-distance travel as intercity travel, as noted by Declan et al. (2018). Long-distance travel is defined as journeys that exceed a specific minimum distance. Declan et al. (2018) observed that intercity travel refers to journeys between cities or other notable locations distanced significantly. The thresholds for long-distance travel vary among different countries. For instance, Kato et al. (2010) noted that in Japan, travel beyond 100 km is classified as inter-urban travel, while the thresholds for long distances range from 50 miles in the UK to 100 miles in the USA (Limtanakool, Dijst, and Lanzendorf, 2003). Intercity transport serves to facilitate mobility between cities (Burgdorf et al., 2018), and the necessity for efficient and sufficient intercity transport services has become essential and unavoidable (Matthews, 2013). Intercity transit is crucial for improving productivity, as it facilitates the movement, transfer, and distribution of individuals and goods.

In Nigeria, inter-state transportation is predominantly characterized by road travel, with a significant number of commuters traveling for business, education, and personal reasons. Studies indicate that fluctuations in inter-state passenger traffic are affected by economic activity, population density, and transportation infrastructure (Abdulrahman et al., 2017). In Nigeria, where urbanization and migration trends affect travel behaviors, these studies are essential for tackling the difficulties related to inter-state travel. Although numerous studies have examined internal migration patterns and inter-city travel in Nigeria (Olorunsola, 2010; Akinpelu, 2014; Olofin, 2018), research explicitly focusing on inter-state passenger movement from Katsina State is few. This study seeks to address this gap by examining the regional and temporal fluctuations in inter-state passenger traffic from Katsina to various selected states in Nigeria. The study will yield insights into peak travel periods, primary destinations, and the determinants affecting passenger flow, thereby informing transportation planning and policy formulation to improve connectivity and stimulate economic growth.

2. LITERATURE REVIEW

Spatiotemporal studies involve the analysis of both space (spatial) and time (temporal) to assess patterns and variations. In transportation research, it enables the evaluation of passenger flow, congestion patterns, and route optimization. It is essential for transport planning and policy-making to research spatio-temporal studies of passenger flow. Having accurate estimates of the flow of passengers can help guide choices regarding the development of infrastructure, the scheduling of services, and. the allocation of resources. According to the findings of a study conducted by Wang et al. (2020), spatio-temporal models have the potential to be utilized to optimize bus timetables and alleviate congestion in urban areas. According to the findings of several studies, the most important factors that influence passenger flow include socioeconomic factors, transportation infrastructure, and seasonal fluctuations. For instance, Liu et al. (2021) conducted a study that investigated the influence of socioeconomic factors on the flow of passengers between cities in China. They discovered

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that economic activity, population density, and transportation facilities have a substantial impact on passenger movements. To improve the efficiency of transportation and to cater to the requirements of travelers, it is vital to research the spatiotemporal variation in the flow of passengers between states that originate from Katsina. By utilizing spatiotemporal models in transportation and statistical models, researchers can discover significant characteristics that drive passenger movements. They may then offer ways to optimize travel routes, minimize congestion, and enhance safety.

2.1 The Study Area

The study area is Urban Katsina, found within the Katsina Local Government Area of Katsina State. It lies between Latitude 12° 40′N and 12° 59′N and Longitude 7° 35′ and 7° 40′E, as contained in the road map of urban Katsina in Figure 2.1. It has a total land area of about 2,448 km^2. The population following the 2006 census was 237,336 (National Population Commission, 2006) while Katsina Local Government's population was estimated to be 541,126 persons in 2022. Katsina is known for high temperatures, particularly during the height of the dry season when it can occasionally reach temperatures of 38 to 40 °C (Adamu 2000). Considering the variation in temperature and rainfall in Katsina, the movement of passengers is affected by these two seasons as passenger movement is high in the dry season and decreases in the rainy season. More than 70% of the population of Katsina are Hausa and Fulani-speaking people whose primary economic activity is agriculture. The Hausa Muslim socio-cultural characteristics and the trade in agricultural commodities necessitate movement to different parts of Nigeria for social and business visits.

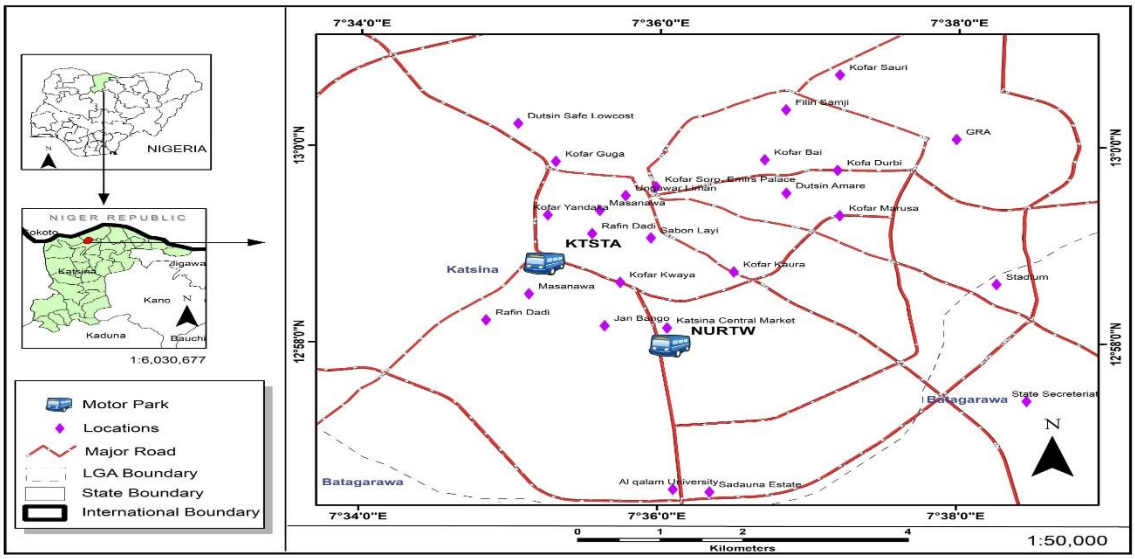

Figure 2.1: Road Map of Urban Katsina Showing the Bus Terminal of Study
Source: Adopted from Google Earth Imagery and Open Street Map, 2021.

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3. METHODOLOGY

The research utilized primary data obtained via a questionnaire sent to inter-state travelers in Katsina at two principal inter-state bus terminals. The bus terminals are the Katsina State Transport Authority (KTSTA) and the Nigerian Union of Road Transport Workers (NURTW) (refer to Figure 2.1). The research gathered the complete population of registered inter-state passengers from the two primary terminals, totaling 250,794 for the year. A sample size of 384 was established via Cochran's method (1977). The allocation of respondents by terminals from the questionnaire administration is illustrated in Table 3.1.

The research utilized both purposive and simple random sampling methods for data collection. Purposive sampling was employed to choose the two principal bus terminals, which encompass public and private transport organizations offering inter-state transport services in Katsina City. KTSTA is owned by the Katsina State Government, whilst NURTW is held by the private entity, the Nigerian Union of Road Transport Workers. A flow line map and bar graph were utilized as methods for data analysis to illustrate the direction of passenger travel, the spatial distribution of the motor parks, the volume of passenger traffic to different places within the country, and the temporal fluctuations in passenger migration from Katsina to other states in Nigeria.

Table 3.1: Distribution of Respondents in the Sampled Bus Terminals

Terminal	Passengers	Bus	Cars	Total
KTSTA	137,937	158	53	211
NURTW	112,857	130	43	173
Total	250,794	258	96	384

Source: Field survey, 2023

4. RESULTS AND DISCUSSION

Sex of the Respondents

Table 4.1 presents data on the gender distribution of passengers engaged in inter-state travel from Katsina. The data indicates that, from a total of 384 users, 65.9% were male and 34.1% were female. The results demonstrate a greater prevalence of out-flow mobility among males in Katsina relative to females. This may indicate a higher engagement of men in the formal labor market, whereas women were more prone to employment in the informal sector or as unpaid family laborers (World Bank, 2021). Women's participation in informal or domestic activities may restrict their mobility to intra-city travel, as they often have limited job schedules necessitating inter-city traveling. The research area is predominantly inhabited by Muslims and Hausa-Fulani tribes, whose cultural factors restrict women's mobility, whereas men exhibit greater mobility and engage more extensively in labor.

Table 4.1: Sex of Respondents

Sex	Frequency	percent
Male	137,937	158
Female	112,857	130
Total	250,794	258

Source: Field survey, 2023.

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Age Group of the Respondents

Figure 4.2 provides information on the age distribution of people involved in inter-state movement out of Katsina City. From the figure, it is evident that the majority of users fall in the age group of 36-40 years, accounting for 22.4%. The next highest age group is 41-45 years, accounting for 19.3% of the respondents. The younger age groups of less than or equal to 20 and 21-25 years had a low frequency of 14 and 34 respectively. This could be because younger people may not have had the financial resources to afford transportation or had not yet entered the workforce, and therefore, need not commute frequently. The higher age groups of 51-55 years and above had a relatively lower percentage, indicating that as people age, they become less mobile and thus reduce their frequency of travel altogether.

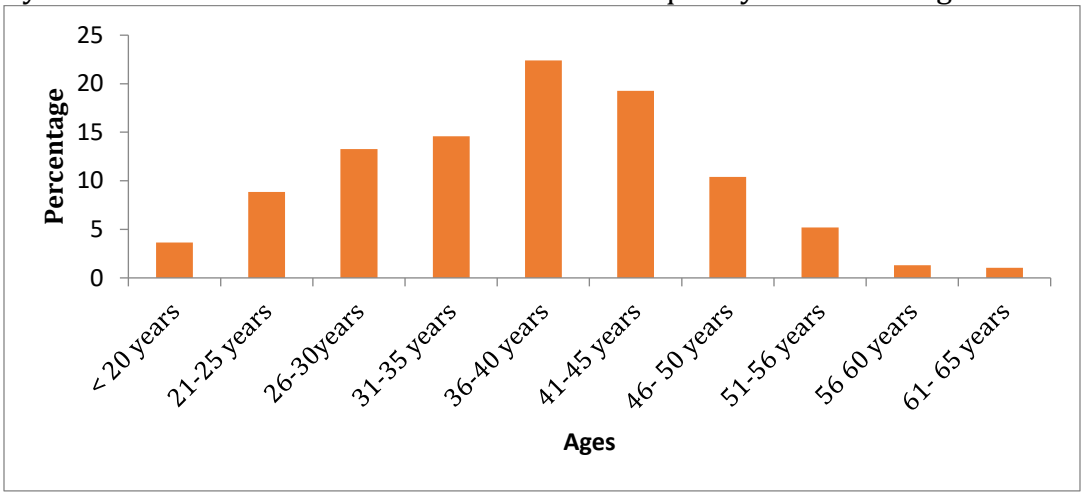

Figure 4.2: Age of the Respondents
Source: Field survey, 2023

Educational Level of the Respondents

Figure 4.3 shows the passenger outflow in Katsina according to educational level. Out of the total sample of 384 individuals, 2.3% had no formal education, 7.8% had primary education, 45.6% had secondary education, and 44.3% had tertiary education. Education level can also play a role in the frequency of movement as well as choice of transportation mode. A study has shown that individuals with higher levels of education are more likely to use private modes of transportation such as cars, while those with lower levels of education are more likely to use public transport (Oduwaye and Aderamo, 2016). This may explain why individuals with tertiary education who may be the working class in this figure have a similar frequency of outflow movement and those with secondary education may not have the reason to frequently move out of the State being students will have less engagement in working activities.

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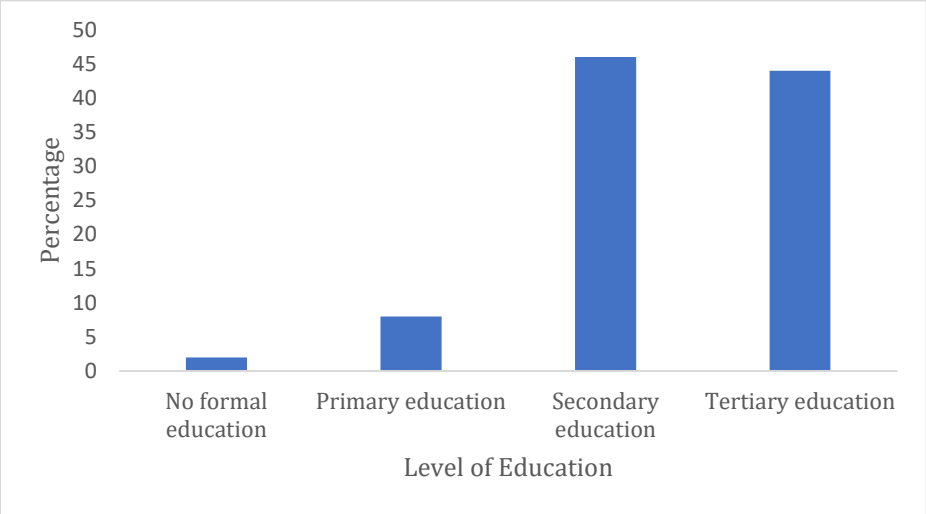

Figure 4.3: Educational Qualifications of the Respondents
Source: Field survey, 2023

Occupation of the Respondents

Figure 4.4 shows the distribution of respondents in the inter-state movement based on occupation. The data indicates that traders (31.8%) make up the largest proportion of people involved in the movement from Katsina to other States in the country. This is followed by the respondents who work in the private sector (24.5%) and civil servants (21.4%). Artisans, on the other hand, account for 17.2% of the total outward movement in Katsina while other types of occupation account for 5.2%. This finding implies that the outflow of passengers from Katsina includes people from both the formal and informal sectors of the economy. Similarly, both private and public sector workers used the two-transport terminal in Katsina for their inter-state travels or journeys. The high percentage of traders involved can be attributed to the fact that many traders in Katsina get their goods from other States within the north-west geopolitical zones and are small business owners who don't have the financial means to purchase and maintain their vehicles. These findings are consistent with studies that found traders as the largest group of public road transport users in Nigeria and low-income earners who cannot afford to own a car or motorcycle, (Ekeocha, 2018; Oluwaseyi and Olaniyi 2018,).

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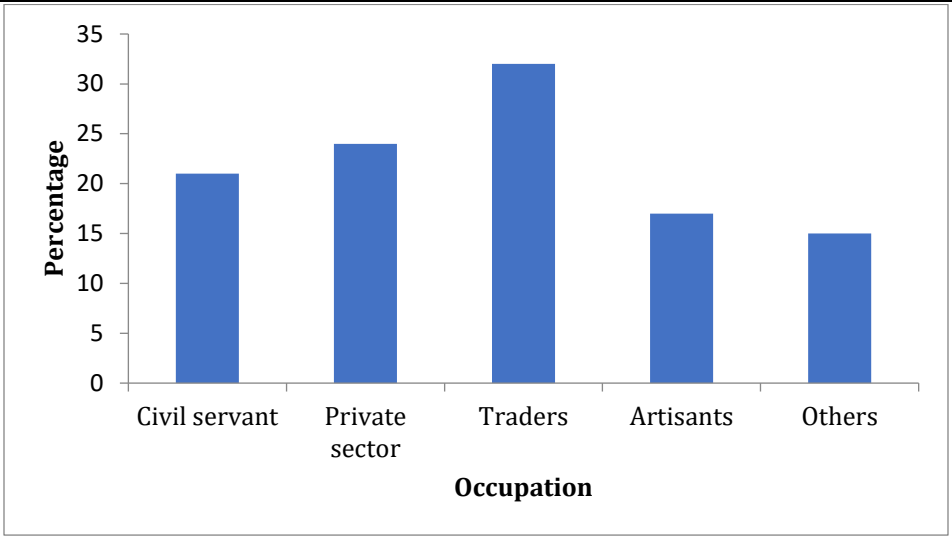

Figure 4.4: Occupation of the Respondents
Source: Field survey, 2023

SPATIO-TEMPORAL VARIATION OF PASSENGER FLOW FROM KATSINA

The pattern of Passengers Flow from NURTW in Katsina to Other States

Figure 4.5 shows the spatial coverage or sphere of influence of the NURTW terminal in Katsina. It shows that passengers travel directly to 11 states across the nation. The states are Kano, Kaduna, Abuja, Gombe, Bauchi, Lagos, Sokoto, Zamfara, Niger, Plateau and Yobe. It is apparent that passenger travel to four States in the North-West zone (Kano, Kaduna, Zamfara, and Sokoto), three States from North-east (Bauchi, Gombe, and Yobe), three States from the north-central (Abuja, Niger, and Plateau) and only one states from South-west which is Lagos. The figure reveals that no passenger travels directly from the sampled terminals in Katsina to south-south and southeast with only Lagos State in the southwest. The data on the direction of passenger flow from Katsina reveals that passenger travels predominantly within the northern part of the country and this is so, because of the proximity and other economic, social, and educational factors. This is established by the gravity model that flow or interaction between places is directly proportional to the product of their population and inversely proportional to their distance apart.

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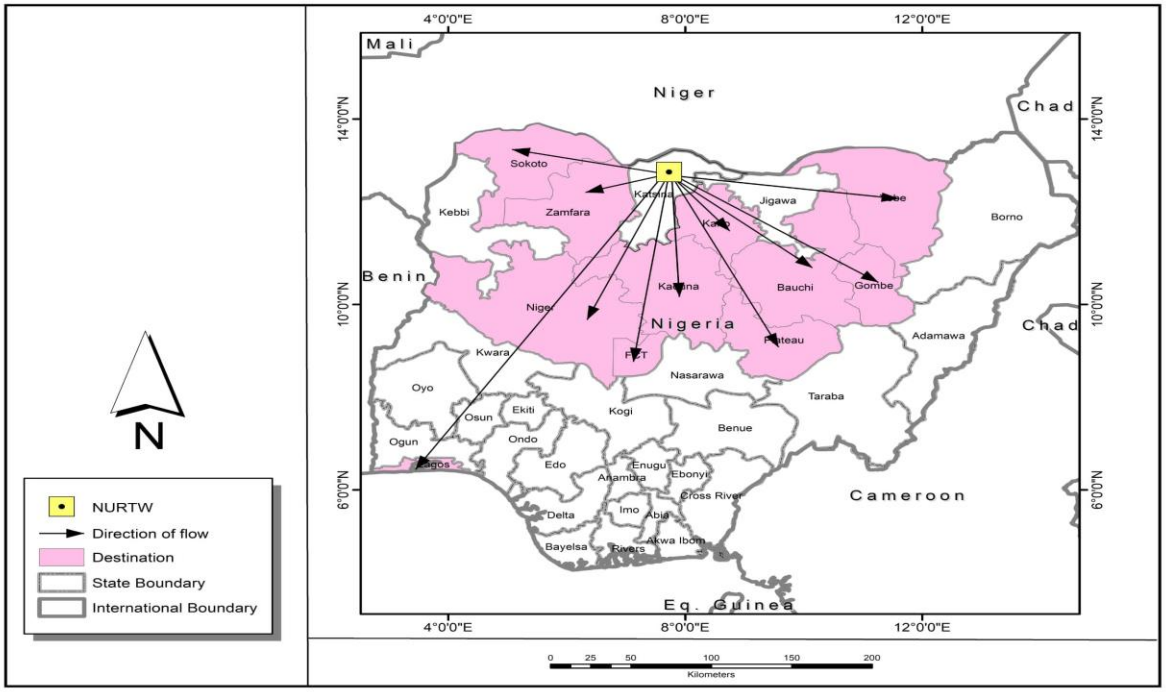

Figure 4.5: Desire Line showing the passenger movement from Katsina (NURTW) to other states.
Source: Adopted and modified from the Nigerian Administrative Map

Pattern of Passenger Flow from KTSTA in Katsina to Other States

Figure 4.6 shows the movement of passengers from KTSTA in Katsina, representing the spatial coverage or sphere of influence of KTSTA in Katsina.

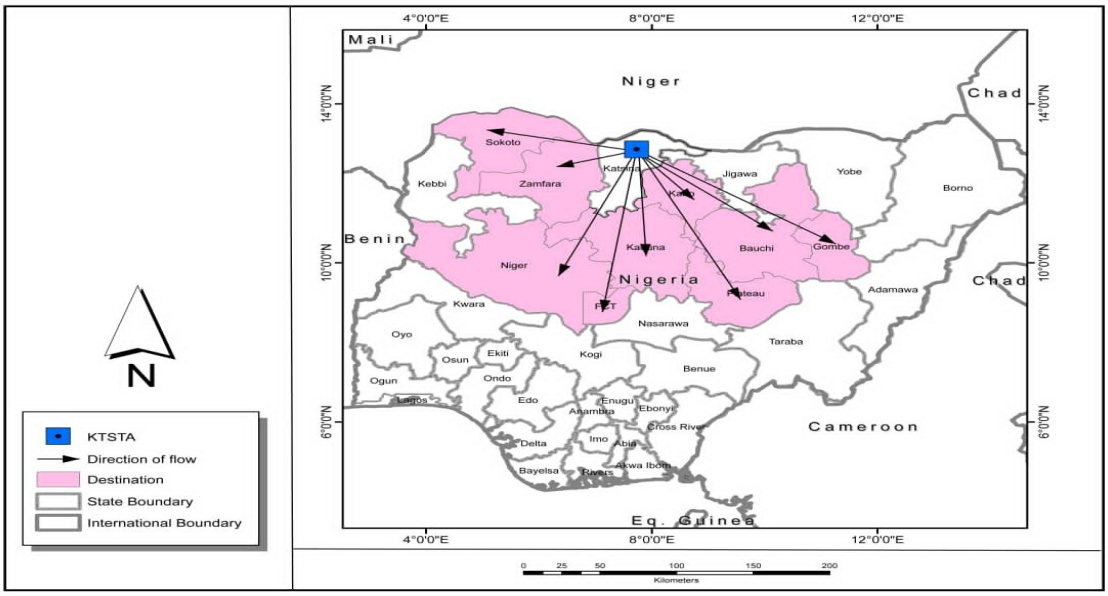

Figure 4.6: Desire Line showing the direction of passenger movement from Katsina (KTSTA) to other states in the country
Source: Adopted and modified from the Nigerian Administrative Map

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Figure 4.6 shows that passenger travels directly to nine (9) States, that is Sokoto, Zamfara, Kano, Kaduna, Bauchi, Gombe, Plateau, Niger states, and Abuja. It is apparent that passenger travel to four States in the North-West zone (Kano, Kaduna, Zamfara, and Sokoto), two States from northeast (Bauchi, and Gombe), and three states from north central (Abuja, Niger, and Plateau). The figure reveals that no passenger travels directly from the sampled terminals in Katsina to south-south and south-east and south-west. The data on the direction of passenger flow from Katsina reveals that passengers travel predominantly within the northern part of the country and this is so, because of the proximity as traders are highly involved. The majority of traders in Katsina normally get their goods from States of proximity to Katsina considering the cost of transport and intervening opportunities available in nearby States.

Generally, the findings reveal that the NURTW terminal has a wider spatial coverage and sphere of influence covering 11 states than the KTSTA terminal covering 9 states within the Nigerian territory. This can be attributed to the fact that KTSTA is a government-owned transport company that prioritizes the need to offer affordable transport service to the citizens of Katsina State and the coverage is limited to not too-long distant places within the northern zone where people can carry out their economic and educational pursuit. NURTW on the other hand is a privately owned transport company that wishes to maximize profit by moving to any part of the country.

The volume of Weekly Passengers Movement from Katsina to Other States

Figure 4.7 provides data on the weekly passenger movement from Katsina to different states within Nigeria. The data reveals the number of passengers traveling from Katsina city to each destination.

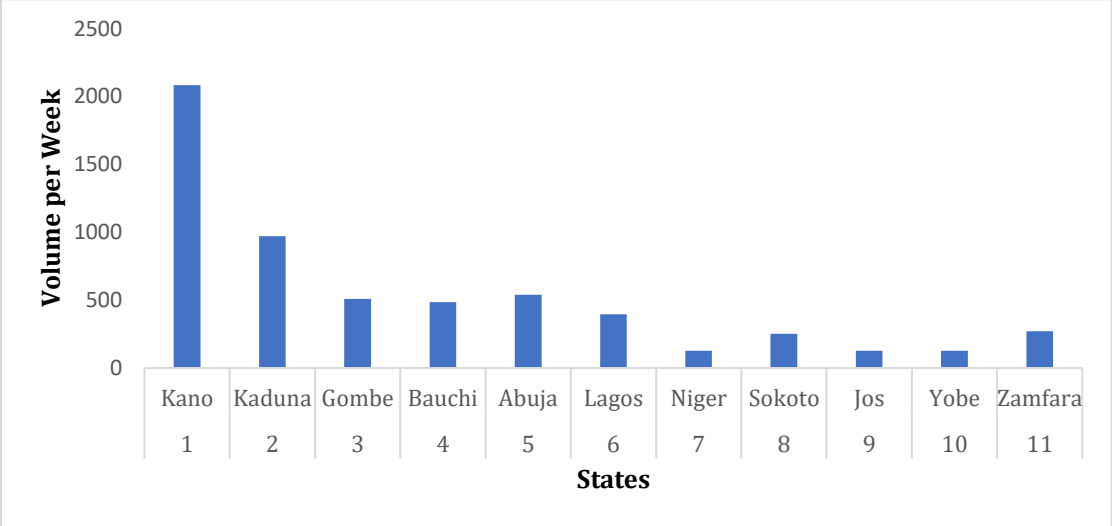

Figure 4.7: Volume of passenger movement from Katsina to other states per week
Source: Field survey, 2023

Kano is the most sought-after destination among the listed States, with 2,084 passengers traveling from Katsina per week, followed by Kaduna with 972 passengers per week. The third most notable destination is Abuja with 540 passengers. Others are Gombe,

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Bauchi, and Lagos with 508, 486, and 396 passengers per week respectively. Zamfara and Sokoto receive 270 and 252 passengers per week. However, the States that receive the least volumes of passengers are Yobe, Niger, and Plateau with 126 passengers each. The finding revealed that Kano, Kaduna, and Abuja are the predominant destinations for passengers from Katsina with Kano receiving the highest volume of passengers. This could be attributed to various factors such as proximity, economic activities, trade, transportation hub, and educational pursuits between the two States. This finding is consistent with the study of Yunusa et al., (2015) which has revealed that passenger flow patterns in Northern Nigeria, including Katsina State are closely tied to economic activities in regions such as Kano, Kaduna, and Abuja.

Similarly, the high flow of passengers seen in Kaduna (972) cannot be unrelated to the high number of students and civil servants working in Katsina who often pay a visit back home. The proximity of Kaduna to Katsina and its significance as an industrial and transportation hub could contribute to this passenger movement. Furthermore, with 540 passengers, Abuja serves as another notable destination. Being the capital city of Nigeria, Abuja attracts people for government-related activities, business, and more. Despite being Nigeria's largest city and major economic hub, Lagos attracted only 396 passengers per week from Katsina. This can be attributed to the distant-decay effect and the presence of Kano State as an intervening spot serving as a major economic centre that tends to limit the volume of interaction between Lagos and Katsina. This can be supported by evidence from the study of Isa (2015) where it was reported that the magnitude of interactions between two locations is determined by distance, population, and economic activities between them. On the other hand, States with the least passenger flow from Katsina are Yobe, Plateau, and Niger. This can be attributed to the distance between the locations and the lack of reasonable complementary goods that can serve as the basis for interaction.

Temporal Variation and Volume in the Movement of Passengers from Katsina Showing the Pattern over the Year

Figure 4.8 shows data on inter-state movement from Katsina to other States in Nigeria for the years 2018 to 2022. The data is broken down by months, and it represents the number of people moving between Katsina and other States for each month.

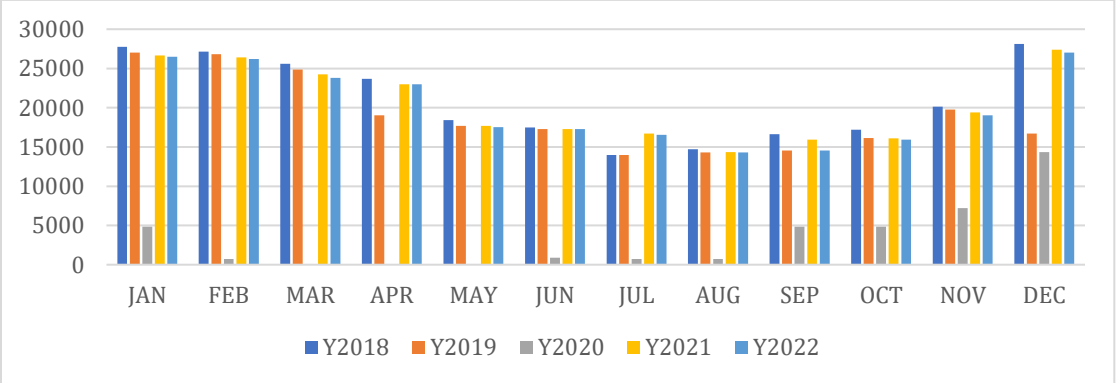

Figure 4.8: Temporal Variation of Movement of Passenger from Katsina
Source: Field survey, 2023

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In January 2018, the number of passengers who traveled from Katsina to other states was 27,738. The highest passenger count was in December (28,114) and the lowest in July (13,960). Passenger movement generally followed a seasonal pattern, with an increase during the latter half of the year. In 2019, the year started with 27,018 people moving in January. Similar to the previous year, there was a gradual decrease over the months, with the lowest movement again in July (13,960) and a slight increase in November (19,764). The data for 2020 shows a significant drop in passenger movement, especially in the first half of the year. This was due to various factors, including the COVID-19 pandemic and associated travel restrictions. In January 2020, there were 4,860 passengers, and this dropped to zero in March and April. Passenger movement started to recover in the latter part of the year, reaching the highest count in December (14,356).

Furthermore, in 2021, there was a rebound in passenger movement, with numbers similar to those in 2019. December had the highest passenger count (27,394), while July had the lowest (16,712). This year-over-year increase could be attributed to relaxing pandemic-related restrictions and improved economic conditions. In 2022, the pattern of passenger movement continued to be similar to 2021, with December (27,034) having the highest passenger count and July (16,532) having the lowest. The data suggests that passenger movement remained relatively stable and consistent in 2022. The data demonstrates a clear seasonal pattern, with passenger numbers generally increasing in the latter part of the year (October to December), which could be related to holidays and festivities. This finding aligned with those of Abdulrahman et al., (2017) that inter-state passenger flow in northern Nigeria varies both diurnally and seasonally, with peaks during the dry season and religious festivities.

5. CONCLUSION

This study reveals important insights into the patterns and dynamics of transportation in Katsina, Nigeria. It highlights that the majority of travelers are married males, predominantly traders and civil servants, whose trips are largely work- or business-related. The NURTW and KTSTA terminals serve as critical transport hubs, with Kano, Kaduna, and Abuja being the most popular destinations. The findings also demonstrate a clear seasonal variation in passenger flow, with peak travel occurring between October and December, and lower volumes in June and July. Understanding these variations can help transport operators and policymakers in Katsina develop strategies that cater to passengers' needs, reduce congestion, and improve overall service delivery.

These patterns underscore the need for targeted interventions to optimize transport services, improve infrastructure, and enhance operational efficiency, particularly during peak travel seasons. It is therefore recommended that transport services should be tailored to meet the specific needs of travelers like offering discounted fares for frequent business travelers or creating loyalty programs for regular passengers to build customer satisfaction and loyalty. Promotion of off-peak travel is required to ease the pressure during peak seasons by providing incentives such as reduced ticket prices during low-demand months (June and July). Moreover, transport operators should plan for the seasonal variation by increasing the number of buses, staff, and services during peak travel months (October to December).

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