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Factors Influencing Intercity Trip Generation of Public Passengers Transport in Niger State

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Abstract

Public transportation is crucial for mobility and economic growth, especially in densely populated urban areas. However, in Niger State, a lack of comprehensive data on peculiar localized factors influencing intercity travel patterns hinders effective planning. This research addresses this gap by analyzing the local factors affecting intercity trips in nine selected cities: Minna, Bida, Suleja, Kontagora, Mokwa, Lapai, New Bussa, Mashegu, and Shiroro. These cities were chosen based on population density, transportation infrastructure, and their roles as transport hubs. A survey was conducted using passenger manifests from major public transport operators, involving 90,775 passengers over four weeks. Dillman's 2007 sample size formula was used to select a sample of 1,290 passengers with a 97% confidence level. Systematic random sampling was employed, and 1,230 valid questionnaires were returned, yielding a 95.3% response rate. Principal Component Analysis (PCA) with varimax rotation identified key factors influencing intercity travel, including income (0.927), vehicle type (0.926), occupation (0.908), travel time (0.900), gender (0.894), and trip cost (0.883). Moderately influential factors were marital status (0.577), trip purpose (0.559), car ownership (0.542), household size (0.515), and age (0.514), while education level (0.473) and trip distance (0.204) had lesser impacts. These findings offer valuable insights for policymakers, urban planners, and transportation authorities to enhance public transport systems and promote sustainable travel in Niger State. The study recommends introducing fare subsidies for low-income passengers to make intercity travel more affordable, increase ridership, and reduce economic barriers to mobility.

Key words: Intercity; Trip Generation; Public Transport; Passenger; Principal Component Analysis (PCA)

1. Introduction

Transportation plays a crucial role in the functioning and survival of any society and economy, as it influences the location and scope of extended activities and the provision of goods and services. More so, it also significantly influences the quality of life. It is a vital component of the connections between the physical environment and patterns of social and economic development (Olorunfemi, 2020). An efficient transportation system is a crucial economic factor and promotes development (Gebre & Quezon, 2021). A well-

functioning intercity transport system has been shown to maximize a city's economic growth. Public transportation is the most effective approach for transporting large groups of individuals, particularly within densely populated urban areas. In addition to promoting the well-being of its users, public transport plays a crucial role in enhancing cities' productivity and national economies (Gbadamosi & Olorunfemi, 2016). Intercity travel is complex because people from different socioeconomic backgrounds travel for other purposes at different times of the day and using various modes of transportation (Usanga *et al.,* 2020).

Studies have shown that the patterns of intercity movement are heavily influenced by various factors, including settlement size, density, topography, journey length, income levels, passenger characteristics, demand for transportation, and city size (Ojekunle *et al*., 2021). Afolabi *et al.* (2016) underscore the substantial impact of land use and urban planning on trip generation. Ojekunle et al.'s (2021) study reveals the influence of socio-demographic variables on trip generation patterns, frequently revealing a positive association between factors like family size and income and the rate of trips taken. Afolabi et al. (2017) and Wojuade & Adewunmi (2017) demonstrate that convenient and easily accessible public transit alternatives can decrease the frequency of trips, providing options that compete with private car usage. Afolabi *et al.* (2017) have demonstrated that fare configurations and the availability of discounts can either incentivize or dissuade passenger travel choices.

Therefore, a comprehensive grasp of these factors is imperative for policymakers, urban planners, and transportation authorities to make well-informed choices to enhance public transport systems and foster sustainable and efficient travel patterns. Meanwhile, there is a conspicuous absence of up-to-date data from a comprehensive study that identifies explicitly and analyzes the peculiar local and contextual factors influencing intercity trips and patterns of public transport passengers in Niger State. In Niger State, the paucity of comprehensive studies and reliable data on factors influencing passengers' intercity travel dynamics hampers strategic planning for inter-city transportation systems (Ohida *et al.,* 2023). This gap impedes a deep understanding of intercity travel, which is crucial for developing coordinated transport systems that meet the evolving mobility needs of the state's growing population (Nwaogbe *et al.* 2017).

Therefore, while it can be said that many researchers have contributed to the knowledge of intercity transport, key determinant factors influencing intercity trips of public passenger transport peculiar to cities within Niger State, Nigeria, have not been adequately addressed. Hence, addressing these research gaps like; poor understanding and limited focus on factors influencing intercity trip generation and travel behavior will help to unravel the relative significance of the causal factors influencing intercity trip demand and ensure the understanding of the present passenger travel patterns, which is fundamental for effective urban mobility planning, infrastructure development, and informed policy-making to accommodate travel demand and optimize intercity transportation systems. The structure of this study includes an introduction, a literature review and theoretical framework, a methodology, results, a discussion, and recommendations.

2. Literature Review and Theoretical Framework

Aworemi & Ajayi (2016) studied factors influencing intercity trip generation in Ifo Local Government Area of Ogun State, Nigeria. His study identified key socioeconomic factors affecting trip generation, including income, number of workers, and age. Moreover, an insufficient understanding of socioeconomic factors influencing intercity trip generation was the gap identified in his study. Solanke & Raji (2021) study focused on the intra-urban trip generation factors in the developing world: a study of Ogun State, Nigeria. Findings Socioeconomic characteristics of urban centres significantly influence trip generation; urban centres explain 53.80%. The research gaps observed from their study were a lack of focus on socioeconomic characteristics of urban centres in trip generation studies.

Ojekunle et al. (2021), who studied the determinants of intercity travel in Nigeria, observed a limited understanding of the socioeconomic determinants affecting intercity travel behaviour. Their findings identified key determinants such as socioeconomic characteristics and travel preferences influencing intercity travel. Owolabi (2010) studied factors that influence intercity travel patterns in Nigeria. It was observed that there is limited data on intercity travel patterns and modal choice influences. Findings show that the average daily work trip per capita in Nigerian cities ranges from 0.97 to 2.0; modal choice is influenced by convenience and cost.

The literature review highlights significant gaps in understanding the socioeconomic and demographic factors influencing an intercity trip generation and travel behaviour, emphasizing the need for more comprehensive research to address these areas in the context of Nigerian cities.

Travel Demand Concept on Intercity Trip for the Study

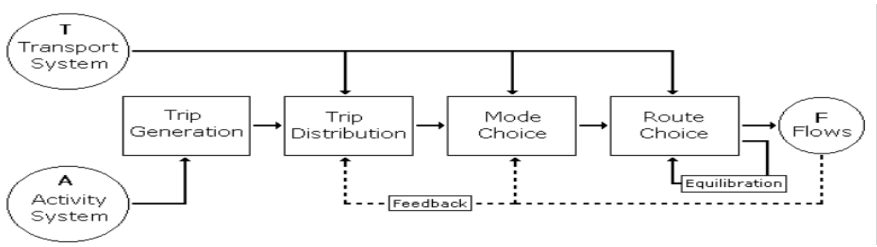

Figure 1: The Four-Step Model
Source: McNally, (2007)

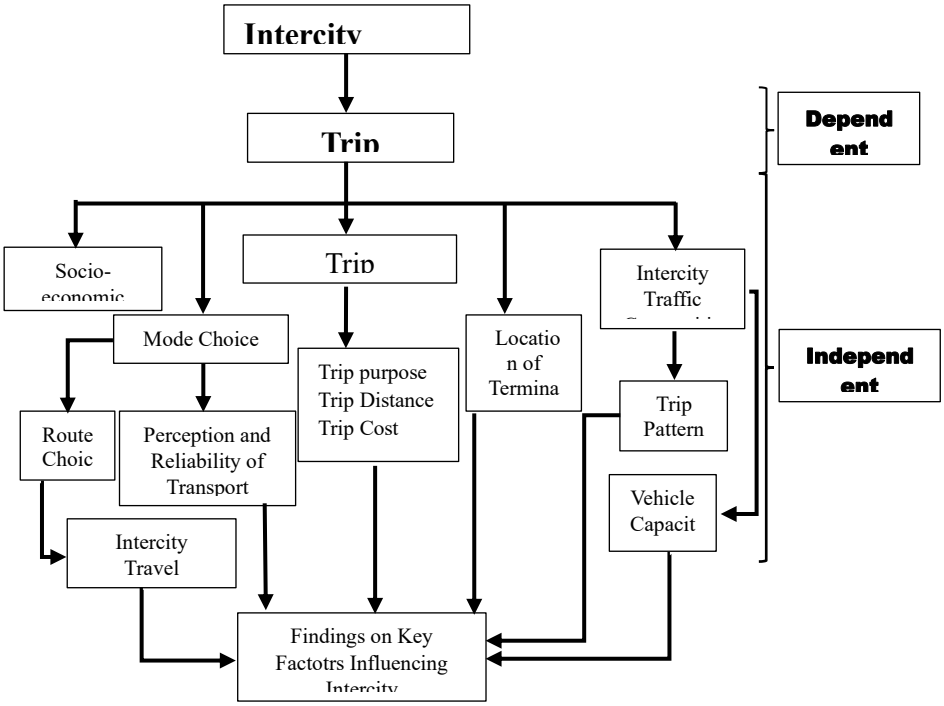

Figure2: Theoretical Framework on Factors Influencing Intercity Trip
Source: Author's Conceptualization (2024)

3. Methodology

The study aims to identify the key factors influencing intercity trip generation of passengers of public transport in Niger State, Nigeria. The selected cities for the study include Minna, Bida, Kontagora, Suleja, Mashegu, Mokwa, Shiroro, New Bussa and Lapai. These cities were chosen due to their high population concentration and serve as transport hubs for direct public transport service from the state capital and other urban centres. They have a well-developed transportation infrastructure, including road networks and bus terminals, aiding accessibility and connectivity coupled with organized intercity bus terminals. The geographical spread of the cities and rural-urban dichotomy also plays a role in the selection. Thereby making them representative of the state's overall demographic and public transportation characteristics.

A survey method was adopted to analyze the key factors influencing the intercity travel demand of passengers of public transport in Niger State, Nigeria. The population of intercity passengers from the nine selected cities were obtained from the passenger manifests of the major public transport operators at designated organized parks in the cities. These operators include the National Union of Road Transport Workers (NURTW), Road Transport Employer Association of Nigeria (RTEAN) and Niger State Transport Authority (NSTA-State-Owned Organized Transport). The data collected for this study was within a time frame of four weeks. From the four weeks of the survey, 90,775 passengers travelled among the cities in the study area (i.e., 40,940 NSTA and 49,835 Private Operators).

Therefore, Dillman's (2007) sample size formula was used to determine the sample size because of its low margin of acceptable error level. To calculate the sample size using the formula given below, we need to substitute the values into the formula:

$$N_s = \frac{(N_p)(p)(1-p)}{(N_p-1)\left(\frac{B}{C}\right)^2+(p)(1-p)} \quad \text{..... (Equation 1)}$$

Where;
Ns = Complete sample size needed (notation often used is n)
Np = Size of the population (notation often used is N) (i.e. 90,775)
P = Proportion expected to answer a certain way (50% 0r 0.5 is most conservative)
B = Acceptable level of sampling error (0.03) = (3%)
C = Z statistic associated with confidence interval = (2.17) (for 97% Confidence level)
Substituting the values into the formula:

$$N_s \approx \frac{(90{,}775)(0.5)(1-0.5)}{(90{,}775-1)\left(\frac{0.03}{2.17}\right)^2+(0.5)(1-0.5)}$$

$$\approx \frac{(22{,}693.75)}{(90{,}774)(0.000191)+(0.25)}$$

$$\approx \frac{22{,}693.75}{(90{,}774)(0.000191)+(0.25)}$$

$$\approx \frac{22{,}693.75}{17.587834}$$

$$N_s \approx 1{,}290$$

Therefore, the required sample size is 1,290 to achieve a 97% confidence level with a 3% margin of error for a population of 90,775

A systematic random sampling technique was adopted to administer the questionnaire for this study. It was adopted due to its balance of simplicity, ease of implementation and improved representativeness. The primary data were obtained through field observations and questionnaire administration of 1,290 intercity public transport passengers at designated and organized motor parks in the study area, and about 95.3% of the questionnaires were returned valid.

Table 1: Population and Sample Size of Passengers

S/No	City	Names of Parks	Population of Passengers (Sample Frame)	No of Questionnaires Administered (Sample Size)	Valid Questionnaires Returned
1	Minna	Abdulsalam, Mobil & NSTA	18,527	263	255
2	Kontagora	Kontagora Central Park	10,162	145	141
3	Bida	Etsu Nupe Garage	10,267	146	139
4	Suleja	Old Garki Garage	10,637	151	148
5	Mokwa	Mokwa Garage	9,012	128	125
6	Mashegu	Mashegu Garage	5,832	83	83
7	Shiroro	Shiroro Garage	8,572	122	119
8	Lapai	Lapai Garage	8,891	126	122
9	New Bussa	New Bussa Central Garage	6,875	126	98
	Total		**90,775**	**1,290**	**1,230**

Source: Author's Field Survey (2024)

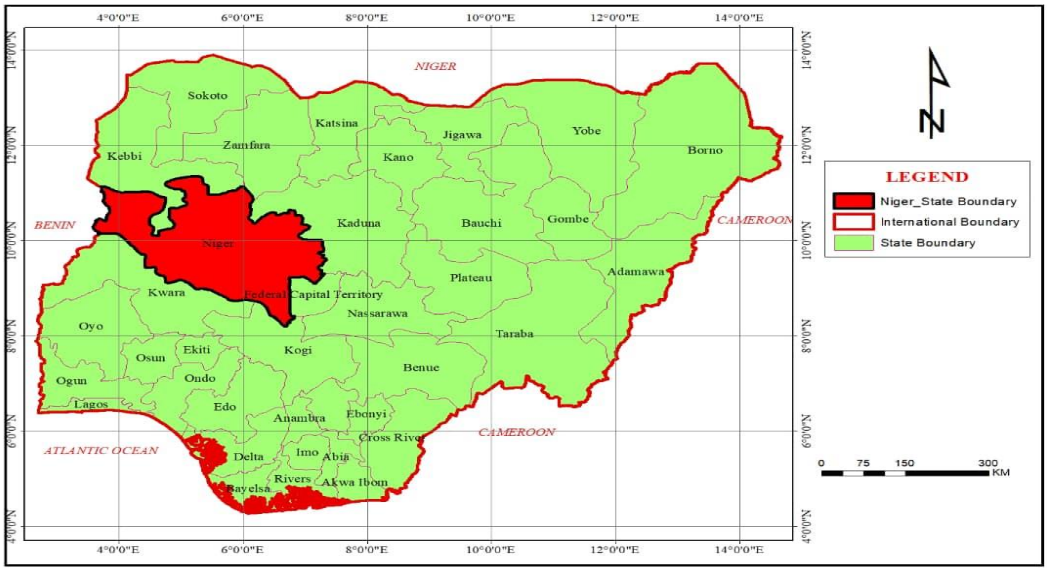

Figure 3: Map of Nigeria in the Context of Niger State
Source: Niger State Ministry of Lands and Housing Minna, (2024)

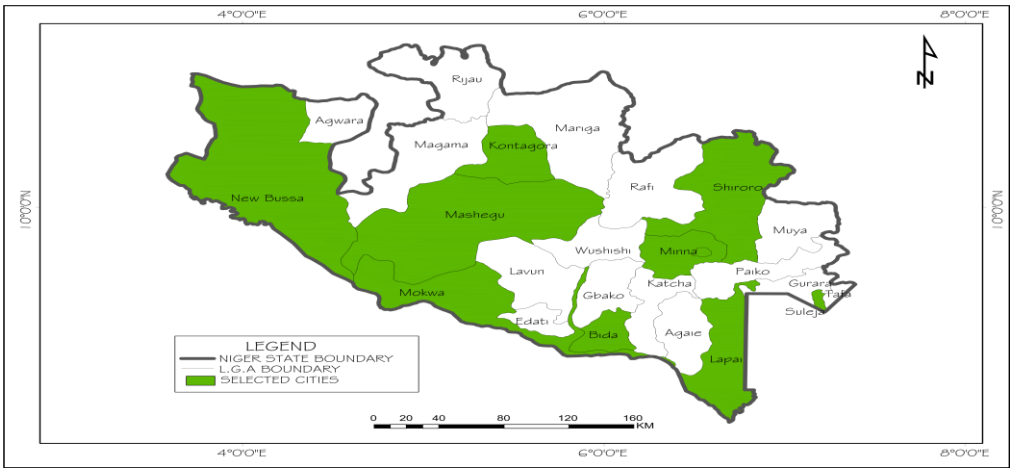

Figure 4: Map of Study Area in the Context of Niger State
Source: Author's Fieldwork (2024)

4. Results and Discussion

To identify the most major factors influencing intercity trip generation of passengers of public transport in Niger State, a principal component analysis with varimax rotation was used, as shown in Table 4.6. Eighteen (18) variables were considered, which include gender, age, marital status, Occupation, household size, Income, educational level, types of vehicle travelling with, car ownership, trip purpose, average waiting time for public transport at motor parks before boarding, time of the day you typically travel, cost of transport, total number of weekly, satisfaction with quality of service, trip distance, insecurity and population. The principal component technique seeks to maximize the sum of squared loadings of each factor extracted.

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.883
Bartlett's Test of Sphericity	Approx. Chi-Square	30624.713
	df	153
	Sig.	.000

Author's Computation (2024)

The study employed the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity, as shown in Table 2. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is a statistical metric that measures the extent to which variables share variance, thereby assessing whether there's adequate common variance among variables to justify performing factor analysis. Generally, a KMO value above 0.6 is considered acceptable, and a value above 0.8 is considered respectable. So, a KMO of 0.883 suggests that the data are highly suitable for factor analysis. In contrast, Bartlett's test assesses whether or not the observed variables intercorrelate using the correlation matrix. Bartlett's test statistic is 30624.713 with 153 degrees of freedom and a significance level (Sig.) of .000, indicating significant correlations among the variables, supporting the suitability of the data for factor analysis.

In the context of intercity trip generation and patterns of public passenger transport in Niger State, these results suggested that the collected data exhibited significant interrelations among variables, indicating that underlying factors influencing intercity trip generation and public transport patterns can be explored using factor analysis.

Table 3: Communalities and Ranking of Components of Factors Influencing Passengers
Intercity Trip

S/No	Component	Initial	Extraction	Ranking
1	Income	1	0.927	1st
2	Type of Vehicle Traveling with	1	0.926	2nd
3	Occupation	1	0.908	3rd
4	The time of the day trip is typically make	1	0.900	4th
5	Gender	1	0.894	5th
6	Cost of Trip	1	0.883	6th
7	Population	1	0.865	7th
8	Satisfaction with intercity transport services	1	0.857	8th
9	Average waiting time for public transport at motor park	1	0.845	9th
10	Insecurity	1	0.763	10th
11	Number of Passenger Per Vehicle	1	0.743	11th
12	Marital Status	1	0.577	12th
13	Trip purpose	1	0.559	13th
14	Car Ownership	1	0.542	14th
15	Household Size	1	0.515	15th
16	Age	1	0.514	16th
17	Education Level	1	0.473	17th
18	Trip Distance	1	0.204	18th

Source: Author's Computation (2024)

Tables 3 present the results and ranking of the communalities of the underlying key influencing factors influencing intercity trips of passengers of public transport in Niger State. Findings show that the following significant factors are those with the highest communalities; Income (0.927) and Type of vehicle (0.926) have the highest communalities, indicating that 92.7% and 92.6% of their variance are explained by the extracted factors, making them crucial determinants. Occupation (0.908) follows closely, and the time of the day when trips are typically made has a communality of 0.900. These high values underscore the strong impact of economic status, vehicle choice, job-related travel needs, and travel timing on intercity travel behaviour. Additionally, gender (0.899), service satisfaction, population size and trip cost also show high communalities (ranging from 0.894 to 0.883), further highlighting their significant role. On the other hand, factors with moderate communalities, like marital status (0.577), trip purpose (0.559), and car ownership (0.542), exhibit their moderate influence on intercity travel decisions.

Household size and age, with communalities of 0.515 and 0.514, respectively, reflect a moderate impact.
Educational level (0.473) and trip distance (0.204) have the lowest communalities, suggesting they have a less critical influence on the intercity trip of passengers. Despite

these lower values, all factors contribute to understanding the complex dynamics of public passenger transport in Niger State. These findings from the Principal Component Analysis (PCA), which rank the significance of various components influencing intercity travel in Niger State, are consistent with the studies of Ojekunle *et al.* 2021 emphasizing the importance of income, mode of travel and occupation as key factors influencing passenger's trip.

Table 4: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
INC	10.007	55.594	55.594	10.007	55.594	55.594	7.998	44.436	44.436
TVTW	1.742	9.678	65.273	1.742	9.678	65.273	3.653	20.295	64.731
OCCUP	1.146	6.369	71.642	1.146	6.369	71.642	1.244	6.911	71.642
TDTM	.996	5.533	77.175						
GEN	.801	4.449	81.624						
CT	.721	4.006	85.630						
POPSIZE	.631	3.507	89.138						
SERSAT	.600	3.333	92.470						
AWT	.433	2.404	94.875						
INSEC	.361	2.004	96.878						
NPV	.132	.735	97.613						
MS	.114	.632	98.245						
TP	.095	.530	98.775						
CO	.072	.401	99.176						
HHS	.053	.296	99.472						
AG	.044	.244	99.717						
EL	.036	.198	99.914						
TD	.015	.086	100.000						

Extraction Method: Principal Component Analysis.

Source: Author's Computation (2024)

NOTE: INC: Income, TVTW: Time of the Day Trip is Made, OCCUP: Occupation, TDMT: Time of the Day Trip is Made, GEN: Gender, CT: Cost of Trip, POPSIZE: Population Size, SERSAT: Service Satisfaction, AWT: Average Waiting Time, INSEC: Insecurity, NPV: Number of Vehicle Per Person, MS: Marital Status, TP: Trip Cost, CO: Car ownership, HHS: Household Size, AG: Age, EL: Education Level and TD: Trip Distance.

The Total Variance explained in Table 4 provides insights into the factors influencing intercity trip generation of public passenger transport in Niger State. The table shows that three components have eigenvalues greater than 1, the standard criterion for retaining components. The first factor (i.e. income) explains 55.596% of the total variance, the second factor (i.e. occupation) explains an additional 9.678% of the variance, and the third component (i.e. Time of the day the trip is made) describes a further 6.369% of the variance. The Principal Component Analysis (PCA) reveals that three components account for 71.64% of the total variance. The high percentage of variance explained by

the first component (55.594%) suggests that it is the most crucial factor influencing intercity trip generation of public passenger transport in Niger State. The remaining components contribute marginally (i.e. 5.53%) to the total variance and are less significant. These findings indicate that a few key factors, represented by the first three components, are responsible for the majority of the variation in intercity trip generation of public passenger transport in Niger State.

The findings on factors influencing intercity trip generation of public passenger transport in Niger State align with existing literature on transportation in developing countries. Studies by Ojekunle et al. (2019; 2021), and Owoeye (2018) similarly identify socioeconomic factors such as Income, Occupation, population, transportation costs, gender, vehicle type, and service satisfaction as key determinants of intercity travel patterns. Policymakers and transportation planners should address these critical factors to improve the efficiency and effectiveness of intercity public transport services in the region.

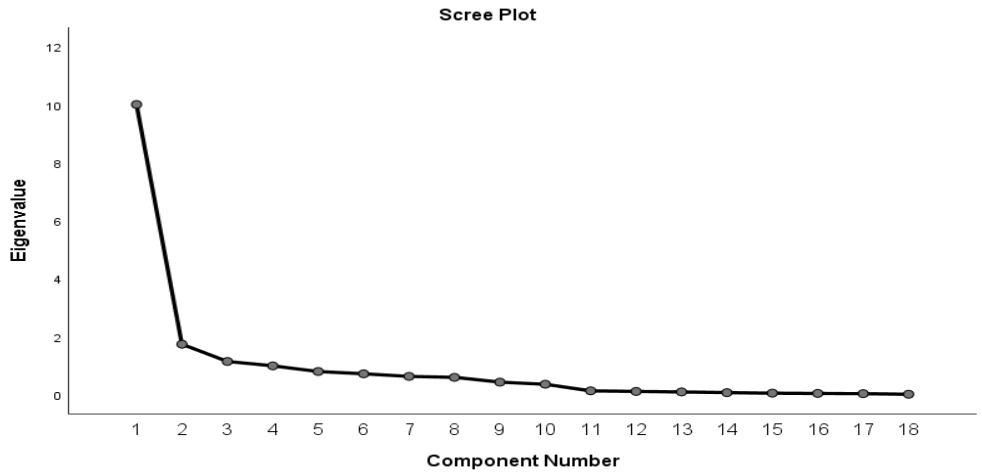

Figure 5. Scree Plot
Source: Author's Computation (2024)

Figure 5 shows the scree plot, which visually represents the variance explained by each principal component, helping to determine the number of components to retain in a Principal Component Analysis (PCA) or factor analysis. On the scree plot, the eigenvalues are plotted on the y-axis while the number of the components is sequentially plotted along the x-axis. The scree plot shows a significant peak in the first component and a steep decline in the next two components, followed by a gradual decrease until it levels off around the eleventh component. This signifies that the first three or four components are most significant in explaining the variance in the data, while additional components contribute less substantially. Therefore, it could be inferred that the first three components are the most influential factors shaping the intercity trip generation of public passenger transport in Niger State.

Finally, the PCA findings closely align with the theoretical framework on factors influencing an intercity trip generation of public passenger transport, highlighting the

importance of socioeconomic factors like income, occupation, and transportation costs as key determinants of travel behaviour. This invariably shows the relationships between socioeconomic, demographic, travel characteristics, service-related factors and how these factors interact through the travel decision-making process to affect intercity travel patterns in Niger State.

5. Conclusion and Recommendations

This study has identified the key factors influencing intercity trip generation among public transport passengers in Niger State, Nigeria. Using Principal Component Analysis (PCA) with varimax rotation, the research pinpointed significant influences such as income, vehicle type, occupation, travel time, gender, and trip cost on intercity travel decisions. The findings reveal the complexity of intercity travel behaviour, driven by socioeconomic and trip-specific factors. Gaining a deeper understanding of these dynamics is essential for designing targeted strategies that enhance public transport systems and foster sustainable travel habits in Niger State. The insights from this study provide a valuable basis for policymakers, urban planners, and transportation authorities to improve transport infrastructure and services, ultimately aiding regional development and economic growth in Niger State, Nigeria.

In line with the findings of this study, the following recommendations were made:

1. There is a need to introduce fare subsidies targeted at low-income passengers to make intercity travel more affordable, increase ridership, and reduce economic barriers to mobility.
2. Government and private public transport operators must diversify vehicle options and adjust travel schedules based on passenger preferences, work schedules and travel times.
3. There is a need for the government to create robust policies to give priority to occupational-related trip passengers, ensuring improved accessibility to public transport services

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