TRANSPORT MANAGEMENT STUDIES IN NIGERIA

A QUANTITATIVE MODELLING APPROACH

FESTSCHRIFT IN HONOUR OF
PROFESSOR INNOCENT CHUKA OGWUDE

$$\sum_{i=1}^{n} \lambda_j \, y_{ri} \geq y_{j\,;} \; r = 1, \ldots \ldots, R$$

$$\sum_{i=1}^{n} \lambda_i \, x_{si}, \leq \theta_{j\,;} x_{j\,;} \; s = 1, \ldots \ldots, S$$

$$\lambda_i \geq 0; \; \forall_i$$

Edited by

Callistus C. Ibe
Donatus E. Onwuegbuchunam
Mobolaji S. Stephen
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TRAVEL CHALLENGES OF URBAN RESIDENTS IN MINNA METROPOLIS, NIGERIA

Ojekunle, Joel Ademola, Owoeye, Adelanke Samuel, Oluwole, Mathew Sunday and Shekwoyemi, Felix Shem

Introduction

Metropolitan cities in recent times have grown to a point where they threaten to strangle the transportation, that made them possible. Up to the 1970s in Nigeria, it was relatively easy to move from one part of the city to the other (Ikya 1993). Urban transportation has turned into a chaotic, complex and almost intractable nature such that most cities almost reach level of relative immobility (Ikya 1993). The productivity of urban areas is highly dependent on the efficiency of its transport system to move labour, consumers and freight between origins and destinations (Rodrigue et al. 2009).

Urbanization has been one of the dominant contemporary process as a growing share of the global population lives in the cities. The necessity for people to move from one place to another is dictated by the spatial spread of events within the spatial environment (Fadare and Salami 2004). This has brought about the emergence of increase in the usage of automobiles resulting into extended trip length and high dependence on car usage (Handy, Weston and Mokhtarian 2005). This invariably poses a lot of travel challenges to urban residents. Human activities must take place in an environment that attracts mobility to the land use within the city center or the hinterland. Activities like working, shopping, religious, recreation and others necessitate the movement of people from one neighbourhood to another. The importance of transportation in this regard cannot be over-emphasized (Ojekunle et al. 2018).

Cities like Minna are locations with a high level of accumulation and concentration of economic activities as well as agricultural activities and it has complex spatial structures that are supported by transport systems (Owoeye 2018). The most important transport problems are often related to urban areas, when transport system for varieties of reasons cannot satisfy the numerous requirements of urban mobility, urban productivity suffers in term of movement of labour, consumers and freight between multiple origins and destinations (Shekwoyemi 2019).

The search for explanation on the travel-challenges facing urban residents in developing countries particularly Nigeria is not a conclusive one. More research has been done to establish various challenges of urban trip generations. It is against this backdrop, that this study attempts to analyse the various challenges confronting urban residents travel in Minna Metropolis, Niger State, Nigeria. No wonder Clifton and Handy (2001) asserted that the more we understand about urban travel behaviour, the more we recognize how much we do not understand, because as one question is answered, new questions emerge, and our appreciation of the complexity of urban travel challenges grows. This study therefore laid emphasis in examining the challenges facing residents travel in Minna.

Literature Review

The study of urban travel behaviour over the last half century has yielded critical insights into the choices that individuals and household make about their daily travel (Clifton and Handy 2001). These insights have contributed to the development of more studies in America, Europe, Asia and Africa with increasingly sophisticated methods by researchers and transport experts to understand and predict travel behaviour. The findings of many of these studies have influenced to a great extent several transport planning decisions and policy issues in many countries of the world (Fadare 1989; Mokhatarian 2002; Srinivasan 2005).

It is noted that several factors affect the travel demand of households in different neighbourhoods, these include; socioeconomic characteristics of household, level of transport infrastructure development, religion, culture, government policy on reproduction, city structure, location of household within city, accessibility to public transport, ownership of means of transport, among others. Scholars like: Fadare 1987, 1989, Owoeye et al. 2018, Ogunjumo 1986, Pucher & Renne 2003 and Fujiwara et al. 2005, have identified household size, car ownership, income, age, gender, number of employed people in the family and occupation among others as major socio-economic attributes of households that influence their travel behaviour in both developed and developing countries.

Filani (2002) states that urban transport systems in developing countries shift as income grows to a higher quality and more costly transportation modes. While in poorer cities the shift is from foot to powered modes to motorized public transport. He argues that the situation is different in developed nations where people shift from public transportation to the private automobiles. Moreover, Gee Gilbert et al. (2004) was of the opinion that the feature and pattern to determine the seriousness of the challenges of urban transportation in a particular city are the urban mobility. They argued that because urban mobility is associated with the purpose of the trips taken by users of the roads which include work, shopping, leisure and social trips, school, hospital, and business trips. However, to achieve all the trips at the reasonable time it depends on the design and level of service of the city.

Adesanya (1996) study found out that locations play a vital role in fuel consumptions and travel distances. The study revealed that population located outside urban cities on average consume three times the fuel compared to those located in the centre of the city. While, outer urban dwellers had the least sustainable travel behaviour which create challenges to policy makers, developers and city planners. Egunjobi 1999 and 2002; suggested that the strongest planning and design of the1city (controls1facilities) will reduce1the1car dependence1and shift to public transport, which1automatically1will alleviate the challenges facing urban transportation. The emergency of the private ownership of public transport has1contributed1to1the chaos of urban transportation systems observed today1in developing countries (Dimitriou11992, Armstrong 11993).

Oyesiku (2002) in his study found out that different transport routes in Nigeria converge with a high degree of compactness, connectivity, density, length and accessibility exhibited within the intra and inter urban road networks which have created chaos and endless congestion in urban transportation. Barter (2001) argued that in order to alleviate the problems involving urban transportation systems, it must be through dialogue, meetings, workshops and seminars, which will involve all people to participate in order to identify problems and suggest the best approaches to solve the problem.

The Study Area

Minna is a rapid budding urban centre in North-Central Nigeria. It is located between latitudes 8°20' N and 11°30' N and between longitude 3°30' E and 7°20' N, and lies entirely with the physical and cultural zone of transition described as the "middle belt of Nigeria" as shown in figure 14.1. Kaduna and Federal Capital Territory border the State to both North-East and South-West respectively. Minna occupied a total land area of 74,344 km^2 and it is approximately 8% of the land area of the country as shown in figure 14.2. Three homogenous residential densities of low, medium and high were recognized in Minna. These residential areas are categorized by social, economic and physical patterns. The city of Minna is the administrative Capital of Niger State in Nigeria with an estimated population 286,838 as at 2016.

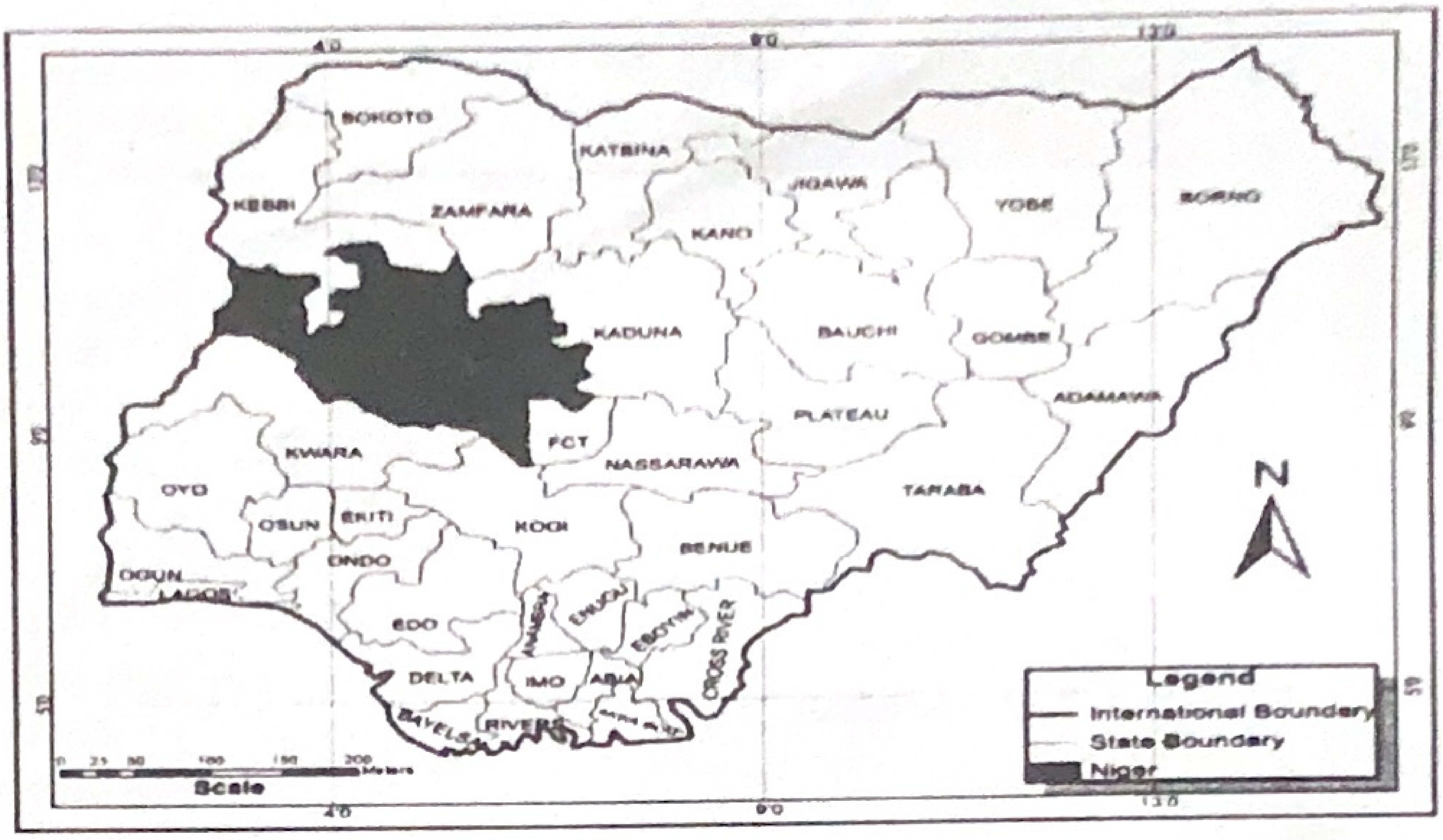

Fig. 14.1: Map of Niger State in the context of Nigeria.

Source: Niger State Ministry of Land and Housing

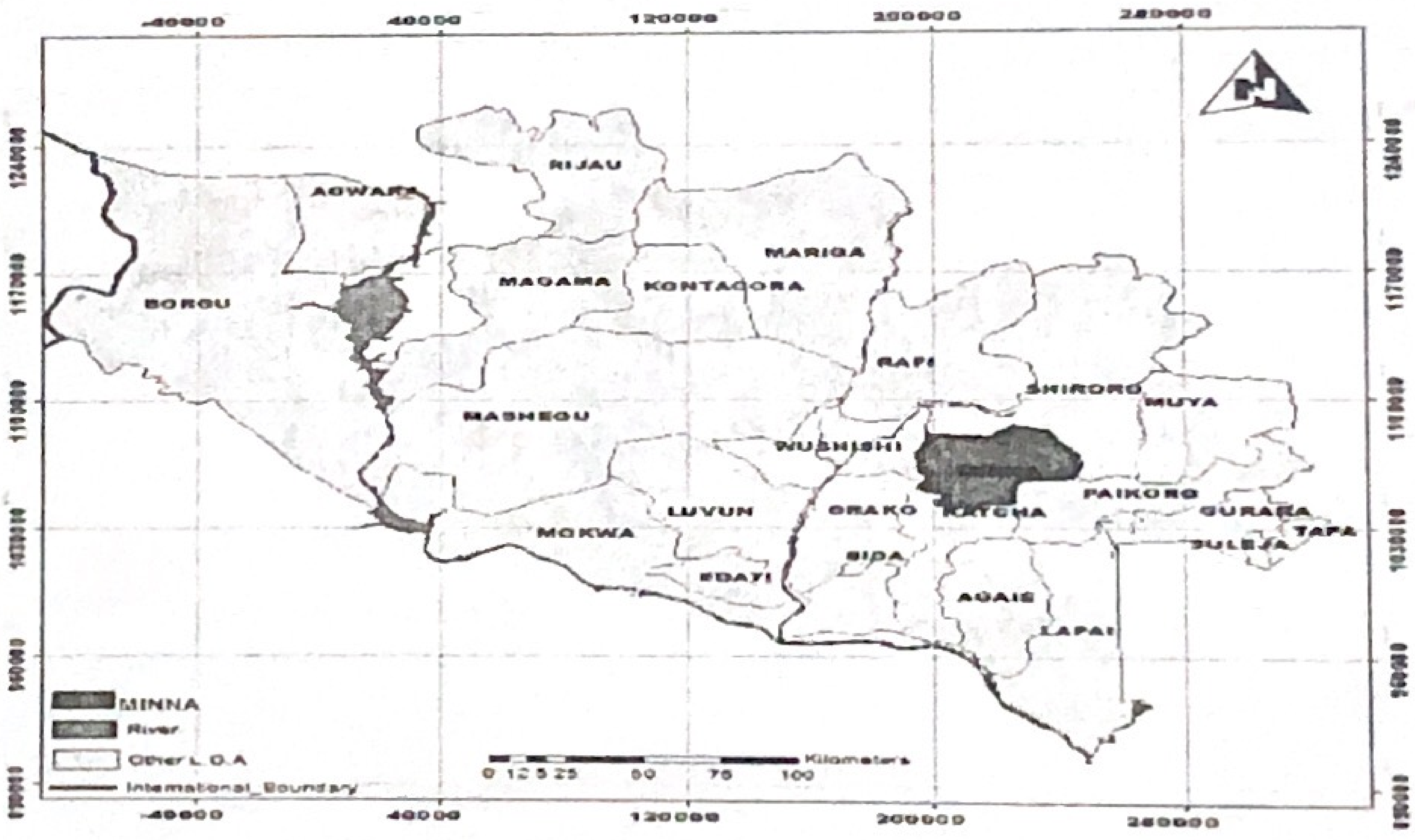

Fig. 14.2: Map of Niger State showing Minna.

Source: Niger State Ministry of Urban and Housing Development (2016)

Methodology

A cross sectional survey approach was adopted from which statistical data were gathered to examine the socio-economic characteristics and travel challenges of respondents in 12 selected neighbourhoods in Minna. A multistage sampling technique was chosen for this study. The study area was divided into four clusters using the major traffic corridors as boundaries. In each cluster, three neighbourhoods of low, medium and high densities were selected in the neighbourhoods. To determine a suitable sample size, the current population of Minna was obtained from National Population Commission record (NPC 2006) and was projected to 2019 to arrive at an estimated population of 182,543 for the 12 selected residential neighbourhoods. Since the household is the target population, according to Nigerian Bureau of Statistics (NBS 2010), an average number of 6 persons live in a household. The population is therefore divided by 6 which gave rise to 30,423 urban residents.

However, this population size is considered too large; a Dillman (2007) formula was adopted for determining the appropriate sample size. Based on this, a total number of 383 sample size was arrived at. 400 Questionnaires were administered to population at the 12 residential locations in the city. The locations were chosen based on the characteristics and densities of residential land uses. The selected neighbourhoods were listed in table 14.1 below. Systematic random sampling method was adopted for questionnaire distribution on residents based on the population of the neighbourhoods. In each neighbourhood, 400 questionnaires were correctly administered and 383 were validly returned for analysis.

Table 14.1: Proportional Samples per Neighbourhoods

S/N	Neighbourhoods	2006 Census Results	2019 Projected Population	Sample Frame
01	Maitumbi	17,775	26,770	4462
02	Angwan Daji	612	922	154
03	GRA	4,274	6,437	1073
04	Barkin Sale	5,862	8,828	1471
05	Tudun Fulani	583	878	146
06	Jikpan	6,604	9,946	1658
07	Tudun-Wada South	4,274	6,437	1073
08	Shango	6,494	9,780	1630
09	F-Layout	6,604	9,946	1658
10	Tunga	6,494	9,780	1630
11	Kpakungu	17,775	26,770	4462
12	Bosso Town	43,856	66,049	11009
	Total	**121,207**	**182,543**	**30,424**

Source: NPC (2006) and Author's projection (2019)

Results and Discussions

The socio-economic attributes analysed in table 14.2 shows that the preponderance of male respondents with 61.2% over female with 39%. Respondents below 21 years were 4.7%, 21-30 years were 27.5% while respondents with age greater than 60 years have 4.7%. Analysis of educational status reveals that 82.5% of respondents have formal education on the aggregate while 17.5% are had no formal education. Table 14.2 also reveals that 54.3% of respondents are employed (47.3% Formal and 7% Informal). Within the context of prevailing income level in Minna Metropolis three income groups were identified (i.e. low, medium and high income). Results shows that 4.7% were low income earners, 14.9% medium while, 80.4% of respondents were high income earners respectively. Respondents with household's size between 5 and 8 were predominant with 57.7% while one car owning households were 52.2% of the respondents sampled.

Table 14.2: Socio-economic Characteristics of Respondents

Variable		Frequency	Percentage
Gender	Male	232	61
	Female	151	39
	Total	**383**	**100**
Age		**Frequency**	**Percentage**
	<21yrs	18	4.7
	21-30yrs	105	27.5
	31-40yrs	71	18.5
	41-50yrs	93	24.3
	51-60yrs	78	20.3
	>60yrs	18	4.7
	Total	**383**	**100**
Education Status		**Frequency**	**Percentage**
	No formal education	67	17.5
	Primary school	74	19.3
	Secondary school	130	34
	Tertiary	112	29.2
	Total	**383**	**100**
Occupation Status		**Frequency**	**Percentage**
	Informal	27	7
	Formal	181	47.3

Table 14.2 contd.

	Students	65	17
	Unemployed	88	23
	Retired	22	5.7
	Total	**383**	**100**
Income status		**Frequency**	**Percentage**
	Low (<#30,000)	18	4.7
	Medium (#30,000-#70,000)	57	14.9
	High (>#70,000)	308	80.4
	Total	**383**	**100**
Household size		**Frequency**	**Percentage**
	Btw 1-4	92	24.0 .
	Btw 5-8	221	57.7
	>8	70	18.3
	Total	**383**	**100**
Car Ownership		**Frequency**	**Percentage**
	Yes	365	95
	No	18	5
	Total	**383**	**100**
Number of Cars in household		**Frequency**	**Percentage**
	0	18	4.7
	1	200	52..2
	2	87	22.7
	3	55	14.4
	>3	23	6
	Total	**888**	**100**

Source: Author's Computer Analysis (2017)

Travel Challenges Faced by Urban Residents in Minna

Figure 14.3, shows the opinion of respondents on travel challenges experienced in the study area. Findings reveal that congestion is the highest challenge of urban mobility in Minna with a frequency of 69 (18%) while accident tends to be the least among the travel challenges faced by Minna residents with frequency of 38 (9.2%).

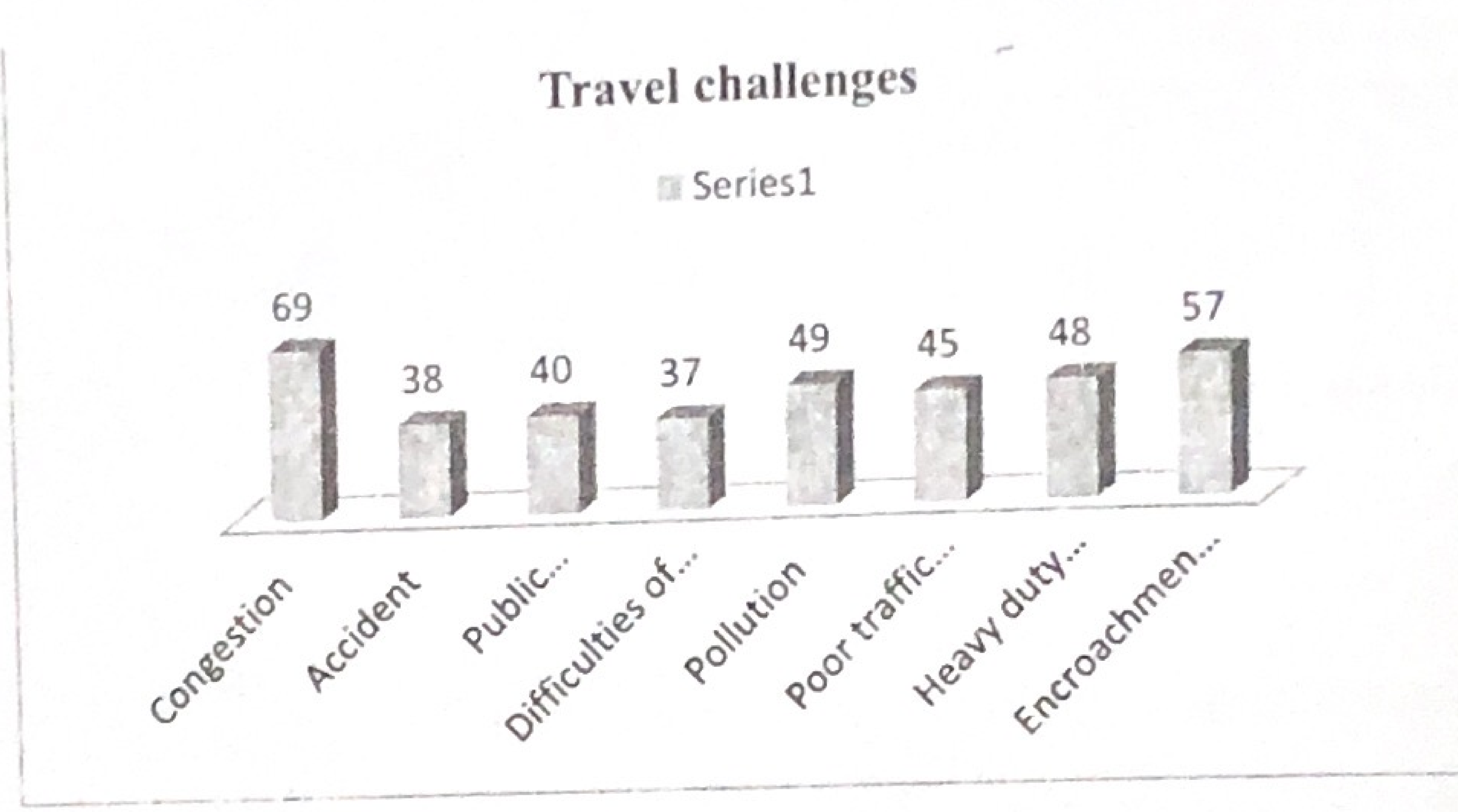

Fig. 14.3: Travel challenges faced by urban residents in Nigeria.

Source: Author's Data Analysis (2019)

Travel difficulties Experienced by Residents

Figure 14.4 shows the travel difficulties experienced by urban residents in Minna. Findings reveal that poor road condition could be seen as the main travel difficulties respondents' experienced in the course of their trip making with frequency of 180 (46.9%). This could be as a result of the narrowness in the width of the roads, successive years of neglect in road maintenance by the various ministries in-charge and lack/poor drainage channels for running off erosion water. While, prolonged travel time and uncomfortable means of transport have the least frequency of 39 (10.2%) each.

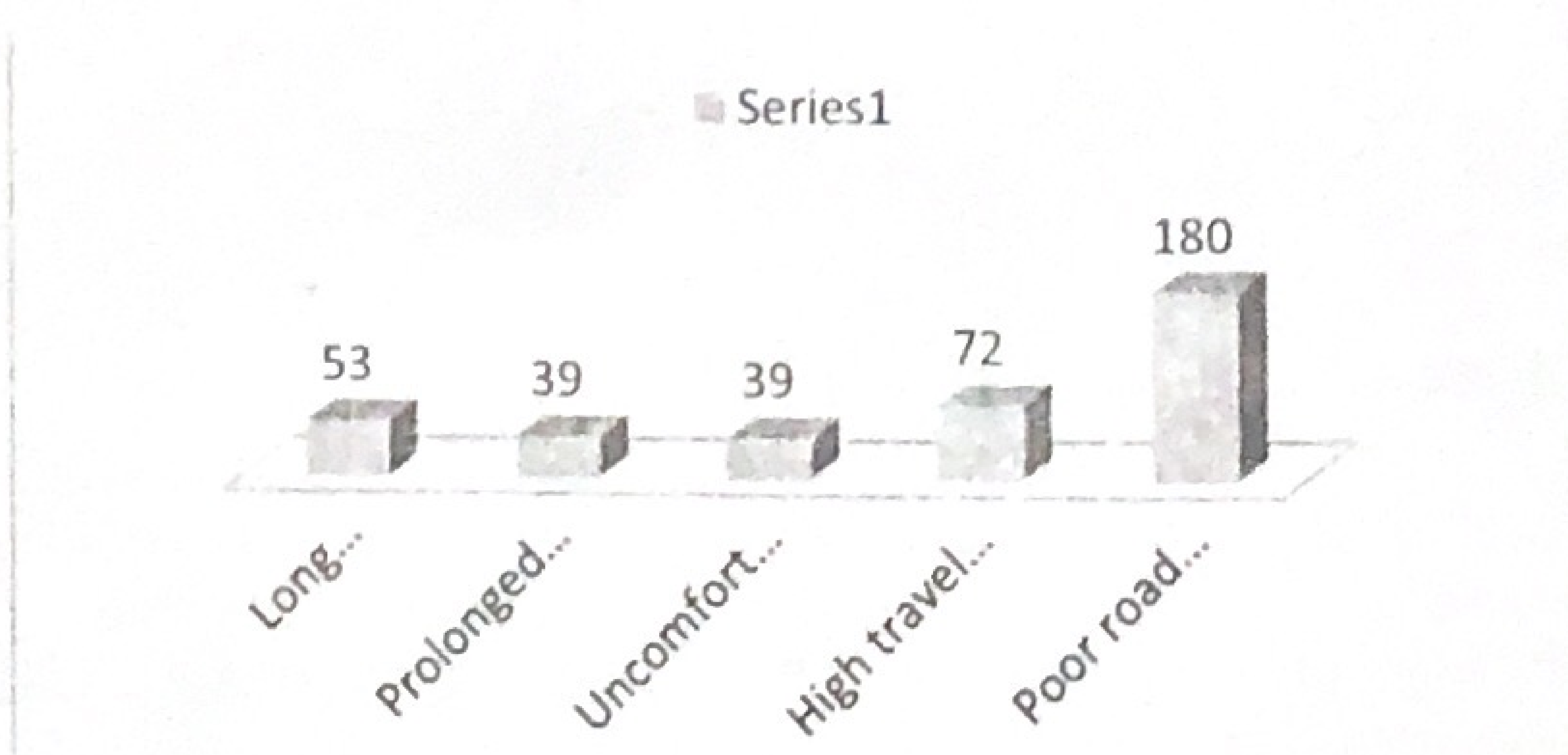

Fig. 14.4: Travel difficulties of trips.

Source: Author's Data Analysis (2019)

The Causes of Travel Challenges in Minna

Table 14.3 shows that bad road condition is the major cause or factor influencing travel challenges with frequency of 100 (26.1%), followed by the use of heavy duty vehicles with a frequency of 82 (21.4%), poor traffic management system with frequency of 80 (20.9%), while poor parking facilities is the least with frequency of 54 (14.1%). With bad road condition as the leading factor, it can therefore lead to congestion as well as accident.

Table 14.3: Causes of Travel Challenges

Factors of travel challenges	Frequency	Percent
Congestion	67	17.5
Poor parking facilities	54	14.1
Heavy duty vehicles	82	21.4
Poor traffic management system	80	20.9
Bad road condition	100	26.1
Total	383	100.0

Source: Author's Data Analysis (2019)

Effect of Poor Road Conditions on Residents Trips

Figure 14.5 shows the impact of the poor condition of roads in the study area, it was observed that reduction in the usage of private cars among residents is the highest casualty of the poor road condition with frequency of 116 of about 30.3%. The poor conditions of roads have also led to the increase in cost of travel (26.1%), reduction in trip rate (22.9%) and reduction in the length of trip distance (20.6%) from one end of the city to another respectively.

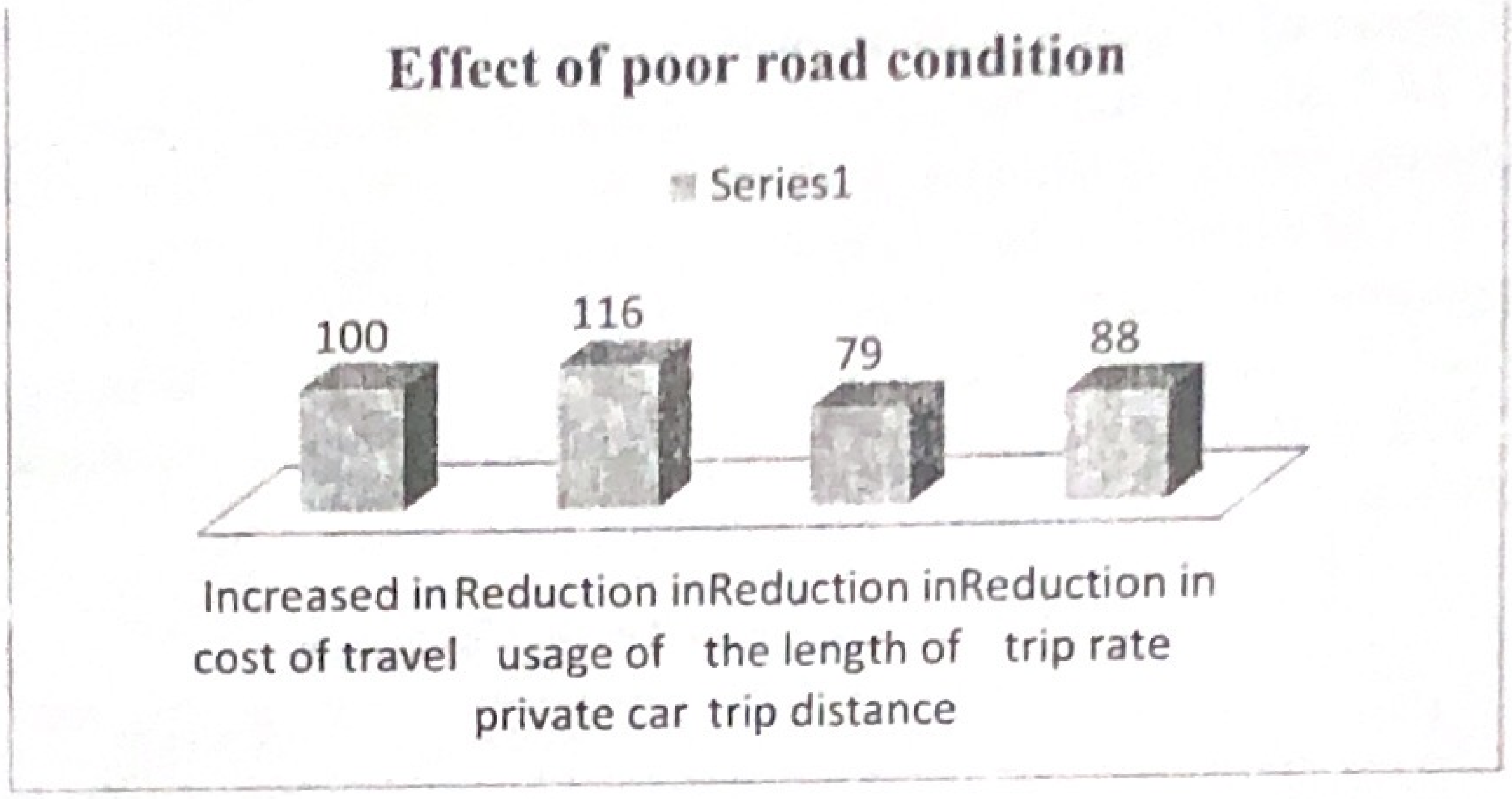

Fig. 14.5: Effect of poor road conditions on trips.

Source: Author's Data Analysis (2019)

The Effect of Travel Challenges on Residents Trip Making

In order to quantitatively analyse the level of effect of travel challenges on trip behaviour of Minna residents, the researcher made use of the Karl Pearson's coefficient of correlation. The Pearson correlation coefficient is used to measure the strength of a linear association among dependent and independent variables. Where the value r = 1 means a perfect positive correlation and the value r = -1 means a perfect negative correlation.

It was used to have an idea of the effect in relationship between the variables X and Y. The correlation model can be conceptualized as:

$$R = \frac{\text{Cov}(x,y)}{\text{STDEV}(X).\ \text{STDEV}(Y)} = \frac{\sigma_{xy}}{\sigma_x .\ \sigma_y} \qquad (14.1)$$

Where;

Y = Dependent variable, X_1-X_{12} = Independent variable

$Y = F(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, \ldots X_{12})$

Y = Total number of weekly trips, X_1= Long waiting time, X_2 = prolonged travel time

X_3 = Uncomfortable means of transport, X_4 = High travel cost, X_5 = Poor condition of the road, X_6 = Congestion, X_7 = Road accidents, X_8 = Poor traffic control system

X_9 = Double parking, X_{10} = Narrow roadways, X_{11} = on street parking, X_{12} = Overloading

Table 14.4: Correlation Analysis

		Total number of weekly trips	high travel cost	poor road condition	congestion	Poor traffic control system	on street trading	overloading
Total number of weekly trips	Pearson Correlation	1	.530**	.566**	-.152**	.154**	.201**	.232**
	Sig. (2-tailed)		0.000	0.000	0.003	0.003	0.000	0.000
	N	382	382	382	382	382	382	382

Correlation is significant at 0.01 level (2-tailed).

Source: Author's Computation (2020)

The result of correlation analysis in table 14.4 shows that of the thirteen variables of travel challenges imputed only six variables were correlated with the total weekly trips made by urban residents at 0.01 significant level. For instance, there is a relationship between poor road condition (X_5) at 57% and high travel cost (X_4) at (53%). This is not surprising because, high travel cost and a poor road condition serves as a major determinant to trip making. This is followed by overloading (X_{12}) at 23%, on street parking (X_{11}) at 20%, Poor traffic control system (X_8) at 15% while there is a negative correlation between total number of weekly trips and congestion (X_6) at -15%.

Factors Influencing Urban Residents Trip Making in Minna

Factor analysis was employed as a technique in order to help the researcher group variables into factor based on correlation between variables. More so, the principal components method under factor analysis was chosen in order to maximize the sum of squared loadings. This will help to identify and extract the maximum possible variance, with successive factoring until there was no further meaningful variance left among the identified determinant factors of travel challenges variables as shown in table 14.5.

Thirteen variables were considered, these include; long waiting time, prolonged travel time, uncomfortable means of transport, high travel cost, poor road condition, total number of weekly trip, congestion, road accident, encroachment on road space, double parking, narrow roadways, on street trading and overloading. The principal components techniques used seem to maximize the sum of squared loadings of each factor extracted in turn.

Factor Analysis Model:

$$X = \mu + L\,F + e \tag{14.2}$$

Where, **X** is the p x 1 vector of measurements, **μ** is the p x 1 vector of means, **L** is a p × m matrix of loadings, **F** is a m × 1 vector of common factors, and **e** is a p × 1 vector of residuals. Here, p represents the number of measurements on a subject or item and m represents the number of common factors. **F** and **e** are assumed to be independent and the individual F's are independent of each other. The mean of **F** and **e** are 0, Cov(F) = I, the identity matrix, and Cov(e) = Ψ, a diagonal matrix. The assumptions about independence of the F's make this an orthogonal factor model.

Under the factor analysis model, the p × p covariance matrix of the data, **X**, is calculated as follows:

$$Cov(X) = L\,L' + \Psi \tag{14.3}$$

Where, **L** is the p × m matrix of loadings, and Ψ is a p × p diagonal matrix. The i^{th} diagonal element of **L L'**, the sum of the squared loadings, is called the i^{th} communality. The communality values can be judged as the percent of variability explained by the common factors. The i^{th} diagonal element of Ψ is called the i^{th} specific variance, or uniqueness. The specific variance is that portion of variability not explained by the common factors. The sizes of the communalities and/or the specific variances can be used to evaluate the goodness of fit.

When the principal components method is used, the matrix of estimated factor loadings, L, is given by:

$$L = \left[\sqrt{\hat{\lambda}_1}\,\hat{e}_1,\ \sqrt{\hat{\lambda}_2}\,\hat{e}_2,\ \ldots\sqrt{\hat{\lambda}_m}\,\hat{e}_m\right] \tag{14.4}$$

$(\hat{\lambda}_i, \hat{e}_i)$ = eigenvalue-eigenvector pairs

Table 14.5: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		654
Bartlett's Test of Sphericity	Approx. Chi-Square	1029.272
	Df	78
	Sig.	.000

Source: Author's Computer Analysis (2020)

The KMO and Bartlett's Test in table 14.5 was used to test the adequacy and validity of the data used for the study, which indicate that it is significantly adequate.

Table 14.6: Factor Analysis Communalities

	Initial	Extraction
Total number of weekly trips	1.000	.722
Long waiting time	1.000	.484
Prolonged travel time	1.000	.520
Uncomfortable means of transport	1.000	.530
High travel cost	1.000	.655
Poor road condition	1.000	.692
Congestion	1.000	.361
Road accident	1.000	.372
Encroachment on road space	1.000	.507
Double parking	1.000	.713
Narrow road ways	1.000	.549
On street trading	1.000	.777
Overloading	1.000	.523
Extraction Method: Principal Component Analysis.		

Source: Author's Computer Analysis (2020)

Table 14.7: Total Variance Explained

Component	Initial Eigenvalues-one			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
OST	2.63	20.232	20.232	2.63	20.232	20.232	2.285	17.58	17.58
TNWT	1.966	15.12	35.352	1.966	15.12	35.352	2.102	16.168	33.747
DP	1.57	12.08	47.432	1.57	12.08	47.432	1.583	12.18	45.928
PRC	1.24	9.536	56.968	1.24	9.536	56.968	1.435	11.041	56.968
HTC	0.947	7.288	64.257						
NRW	0.863	6.639	70.895						
UMT	0.816	6.276	77.171						
OL	0.729	5.604	82.775						
PTT	0.638	4.907	87.682						
EORS	0.523	4.024	91.706						
LWT	0.478	3.678	95.384						
RA	0.385	2.96	98.344						
CONG	0.215	1.656	100						

Extraction Method: Principal Component Analysis.

Source: Author's Computer Analysis (2020)

****Note:*** OST: On Street Trading, TNWT: Total Number of Weekly Trips, DP: Double Parking, PRC: Poor Road Condition, HTC: High Travel Cost, NRW: Narrow Road Ways, UMT: Uncomfortable Means of Transport, OL: Over Loading, PTT: Prolonged Travel Time EORS: Encroachment on

Road Space, LWT: Long Waiting Time, RA: Road Accident, CONG.: Congestion.

Using the eigenvalues-one criteria (i.e. Kaiser1960 criterion) table 14.7 explains the result of total variance of the challenging factors influencing urban resident travel. The result reveals that 4 factors whose eigenvalues are greater than 1 accounted for 57% of the total variance. The cumulative value of the first four factors is 57% with factor 1 accounting for 20.23%.

The result confirmed that street parking explained 20.23% of the total variance influencing urban travel while a total number of weekly trips, double parking and poor road condition explains 15.2%, 12.08% and 9.53% respectively. The implication of this outcome on urban residents travel is that travel challenges (i.e. on street parking, total number of weekly trips, double parking and poor road condition) have significant influence on urban residents travel in the study area. A cursory look at the scree plot in figure 14.6 shows that 4 factor were extracted (point of sharp and sudden change in slope) of which factor 1-4 account for more than 56% of the changes in variance which is relative to the remaining 9 factors (i.e. 5-13). These variables according to their order of ranking from 1-13 include; on street trading, total number of weekly trips, double-parking, poor road condition, high travel cost, narrow road ways, uncomfortable means of transport, over loading, prolonged travel time, encroachment on road space, long waiting time, road accident and congestion.

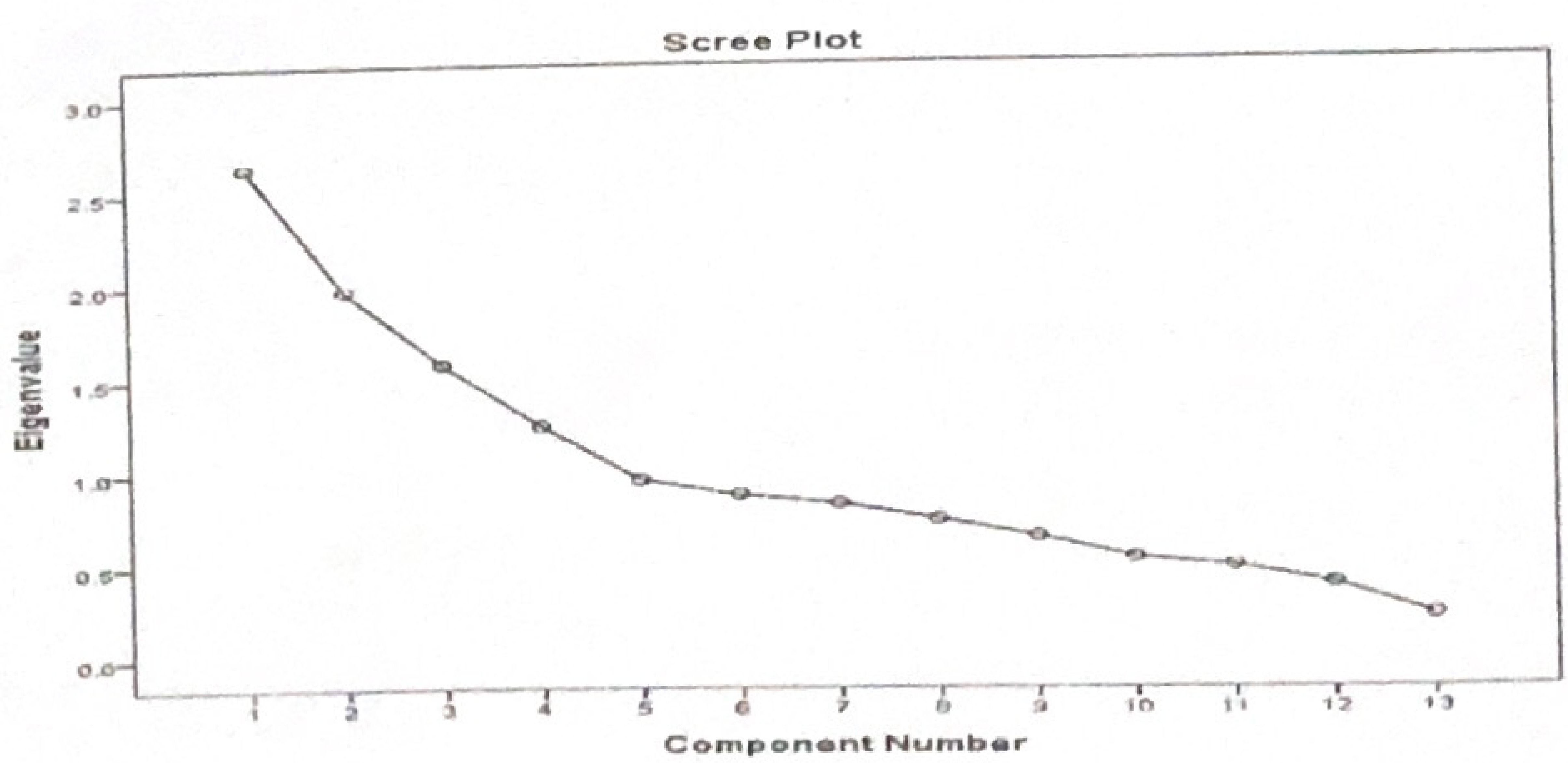

Fig. 14.6: Scree plot.

Source: Author's Computer Analysis (2020)

The result of the extraction method in table 14.8 and 14.9 after ranking the output reveals that the factors with the highest output were on street trading (0.777), total number of weekly trips (0.722), double parking (0.713), poor road condition (0.692), high travel cost (0.655), narrow road ways (0.549), over loading (0.523), prolonged travel time (0.520), encroachment on road space (0.507), long waiting time (0.484), road accident (0.372) and congestion (0.361).

Conclusion and Recommendations

In general, the study revealed that urban travel is a complex form of travel and it is associated with various challenges. From the analysis, it can be seen that the major factors affecting urban mobility in Minna are on street trading, double parking along the road and poor road condition. Solving urban challenges in Nigerian cities require that adequate attention be paid to those factors that significantly affect smooth movement of urban travel and general mobility of city residents particularly in Minna.

Recommendations

In order to ameliorate the various travel challenges faced by urban residents in Minna. The followings are recommended;

(i) effective enforcement mechanism to discourage street trading through the
(ii) provision of affordable lock-up shops;
(iii) strict enforcement of existing vehicular parking rules;
(iv) provision of robust and functional traffic management system;
(v) prompt maintenance of existing failed roads within the city; and
(vi) provision of high occupancy vehicles at an affordable fare as a means of public transport service to discourage private car owners from plying the road.

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