

# Accessibility to Bus Terminals: A Statistical Analysis of Commuter's Perception and Socio-Demographic Characteristics

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## ABSTRACT

This study analysis accessibility of commuters to bus stops within Kaduna metropolis. Bus stop accessibility is a vital component of a successful transportation system. The research evaluates accessibility to bus stops within Kaduna metropolis. The sources of data for the study include a structured questionnaire, satellite imagery and a Global Navigation Satellite System. The study took a socio-demographic dimension and obtained data from the structured questionnaire; the data included variables such as; walking distance, passengers fare, waiting time, bus availability and means of accessing bus stop. Purposive sampling was used to select 12 bus stops with the highest activity within the study area. 400 bus commuters were purposively interviewed, those waiting to board or alight buses at the bus stop using a schedule. For a presentation of the summarized data, descriptive and inferential statistics were used. A regression model was also used to determine which of the variables on the questionnaire are significant in showing problems of accessibility. This revealed that trip fare, place of access, waiting time and walking distance are positively significant problems of accessibility. The study concluded that using socio-demographic characteristics to determine accessibility is quite essential as not only a spatial analysis are used to determine accessibility.

**Keywords:** *Capsicum annuum*; Land suitability analysis; AHP, GIS, Multi-criteria evaluation.

## INTRODUCTION

Public transport plays a key role in ensuring accessibility to activities and services [1]. There are many influences on the use of public transport which include spatial access, cost, physical accessibility, information and attitudes which all contribute to people's ability and motivation to use public transport [2] in a study on human settlements explained that transportation and land use have been closely linked. People settle in areas that are amenable to access by the modes of transportation available. According to [3-5], there is an increasing demand to improve the performance of public transport to make transport systems sustainable in both developing and developed countries.

Several studies on accessibility focus on different variables. [6,7] focused on how accessibility is measured and the theoretical basis for measuring accessibility but the study did not look at the impact of the commuter's socio-economic characteristics on accessibility conducted a research on accessibility to bus stops, but they hinged the research on passengers' perception, the research was based only on how commuters and drivers perceived accessibility.

Kaduna metropolis has no defined bus transport system as well as professionally determined bus stops; this has resulted in indiscriminate boarding and alighting along the route did a similar research to this within the same study area, but worked under the assumption that the existing bus stops were designated by the government, there is however no existing document to that effect [8]. However worked on collecting data from 8 bus stops where there exist 63 bus stops according to Kaduna State Traffic and Environment Law Enforcement Authority (2016). This research however aimed at measuring accessibility to bus stops on the basis of commuter's socio-economic characteristics and responses to accessibility indicators.

## LITERATURE REVIEW

Accessibility is most commonly measured in the special sense; this is common because when a place is not physically accessible, it is termed in accessible. This is true; however, there are other factors that have to be in place in addition to the physical accessibility in order to have a holistic approach in studying accessibility in their various researches on bus stop accessibility and service quality respectively have shown great interest in customer satisfaction

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and accessibility measurements, they have highlighted service accessibility indicators which can be used by a transit operator in order to evaluate their performances [9]. The indicators of accessibility include; service availability, services reliability, comfort, cleanliness, safety and security, fare, information, customer care and environmental impacts [10].

Service availability as studied by the category of service aspects are represented by [11,12] is understood to be characteristics of the route of the bus line in terms of path and coverage, number of bus stops, distance between bus stops, location of bus stops, and characteristics of the service, like frequency, span of service, travel time, need for transfer. Secondly, service reliability is the indicator where public transit agencies have developed multiple indicators to measure service reliability, but the three most common measures are on-time performance, headway regularity and running time adherence [13]. Service reliability is quite important because when it is unreliable, it by implication causes additional travel and waiting time for passengers [14,15]. Thirdly, Transportation Research Board (2003) [16] discussed comfort as the indicator where what is considered at bus stops includes shelters, benches, vending machines, trash receptacles, lighting, phone booths, and so on. Safety and Security connotes safety from crime or accidents and the feeling of security resulting from psychological factors highlighted the importance of this indicator in their study [17]. Another indicator as researched is the fare paid for transportation [18]. This is the money paid by passengers as a partial or full contribution to the operational cost of the transport system [19].

Accessibility indicators are identified based on their complexities. The most complex accessibility indicators consider the connectivity of transport networks. This is done by differentiating the network itself from the activities or opportunities that can be accessed by it. The indicators generally include spatial impedance which is understood to be the ease of reaching destinations of interest, usually measured in terms of travel time, cost or inconvenience [20]. According to Vulevic, Accessibility indicators can be classified by the way they specify the destination and the impedance functions. Travel cost indicators estimate the total or average travel cost to known set of destinations [21].

Daily accessibility is the indicator which has the time component attached to it. Maximum travel times of between three and five hours one-way are commonly used for this indicator type. Potential accessibility is the indicator most frequently applied and most extensively tested. An area is said to be accessible from the total destinations other areas that can be reached from it. Other indicators as posited by include Link travel time by transport mode and Origin-destination travel times by transport mode which measure accessibility to population [22]. The indicators also include the Link travel cost by transport mode and Origin-destination travel costs by transport mode or multimodal and type of traveller which are tied to economic activity.

## STUDY AREA

The study area is Kaduna metropolis which is the capital of Kaduna State (Figure 1), Nigeria comprising of Kaduna North, Kaduna South, some parts of Chikun and Igabi Local Government area. The total area coverage is about 118km<sup>2</sup> (Kaduna State Planning and Budget commission, 2017). According to Kaduna State Planning and Budget commission, (2017), the metropolis

is located in between Latitudes 10°25'15"N and 10°36'08"N and Longitudes 7°23'31"E and 7°29'33"E. As at the 2006 census, the Metropolis had a population of 1,032,288 projected to 2018 at a growth rate of 3.18, the population of Kaduna Metropolis is 1,608,146 (Kaduna State Planning and Budget commission, 2017). Kaduna is a nodal town with roads, railway and an airport which connects it to other parts of the country. The location of Kaduna town as a junction town by road and rail transport systems facilitates commercial activities [23].

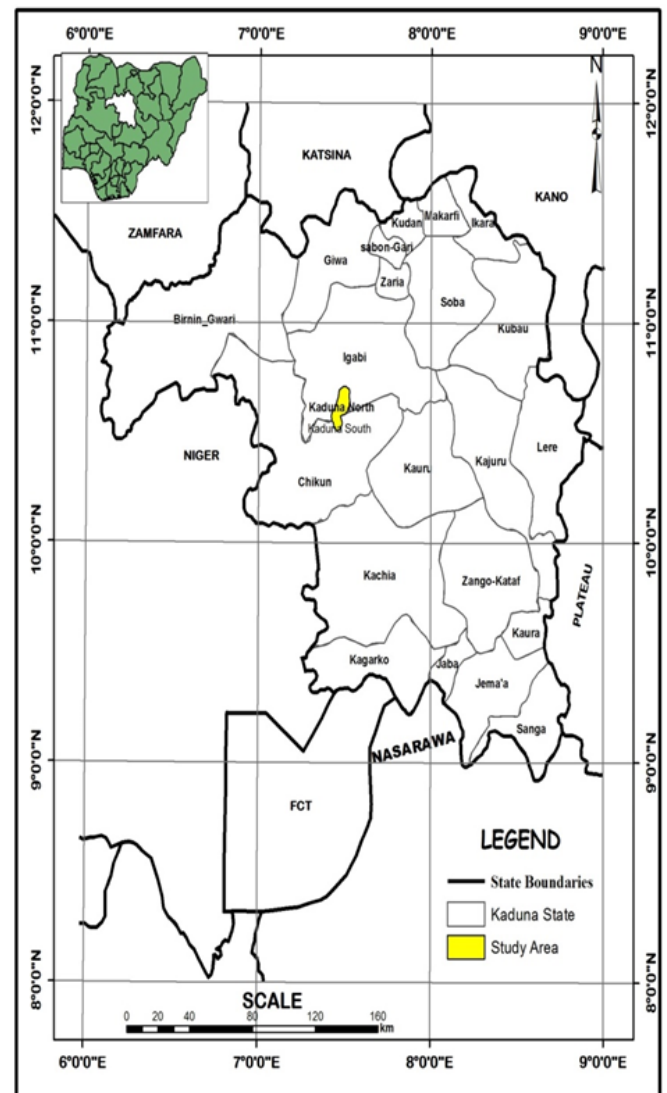


Figure 1: Kaduna State Showing Study Area

## MATERIAL AND METHODS

Getting acquainted with the environment and the data requirements for the study, within the study area were carried out through a reconnaissance survey. A questionnaire was designed to obtain data on socio-economic characteristics of the people, their perception on the nature of bus service operation and accessibility problems they encounter.

Purposive sampling technique was used in the selection of bus stops where the commuters were interviewed. The purposive technique was preferred in this research because it enabled the choice of respondents who are directly concerned with accessing bus stops and who were willing to respond appropriately and quickly to the questionnaire. A questionnaire was designed and

administered to bus passengers. In each of the selected bus stops, commuters were interviewed while waiting for bus to be boarded at the terminals. Information on socio-economic characteristics, mode of travel to bus stop, affordability, bus stops characteristics, travel time, safety measures and problems encountered by the bus users were obtained from the commuters. The interviews were conducted all days of the week, (Monday- Sunday); data were collected at morning peak period (7am-9am), afternoon off peak period (12pm-2pm) and evening peak period (4pm-6pm). This lasted for a period of 2 Months, the months of February and March, 2018.

Questionnaire responses from passengers were used to determine the accessibility to bus transportation. This was analyzed using Tables, Charts, and Descriptive statistics. Inferential statistics was employed to determine the relationship between means of accessibility and fare charged for transport, gender, income, age and occupation of respondents to the questionnaire on accessibility.

The routes considered for this study were the major roads within Kaduna metropolis as seen in (Figure 2). The bus counts data for the selected bus stops were used. According to the Kaduna State Traffic and Environmental Law Enforcement Agency bus stop enumeration exercise, 63 bus stops exist. A GPS was used to get the locations of each existing bus stop as seen in (Figure 2). The sample size for respondents to the questionnaire administered was 400. The number of respondents at each bus stop was achieved through stratification after purposively selecting 12 sample points with over 1000 buses counted at the bus stop per day.



Figure 2: Kaduna Metropolis Showing Road Networks and Bus Stops

## RESULTS AND DISCUSSION

The data analysis and discussion of the results were generated from copies of a questionnaire and field measurements. It covers the analyzed results on commuter’s responses and socio-demographic characteristics.

### Socio-Demographic Characteristics of Commuters

The socio-demographic characteristics of the respondents within Kaduna metropolis are shown in (Table 1).

Table 1: Distribution of Respondents Based on Sex

Sex of Respondents	Frequency	Percent
Male	212	53.0
Female	188	47.0
Total	400	100
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Male	212	53.0
Female	188	47.0
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Sex of Respondents	teristics	teristics

### Sex Distribution of the Respondents

The male respondents’ are more than the female due to the nature of activities in the metropolis which are men oriented. (Table 1) shows that 52.5% of the passengers are male while 47.5% are female.

The (Table 1) revealed that male access bus stop from adjoining land areas more than female in the study area. The active involvement of male respondents in socio economic activities in the quest of providing for their household forms the basis for their high distribution. The purpose for less accessibility to bus stop by female respondents was credited to religious and cultural factors which curtail their participation in some socioeconomic activities.

### Age Distribution of the Commuters

This variable shows the age distribution of commuters who access the bus stops. (Table 2) inferred that respondents within the age range of 26-35 years have highest percentage of 41% while respondents above 56 have least percentage of 2%. This showed that access to bus stops in Kaduna metropolis involves a wide age range.

Table 2: Distribution of Respondents Based on Age

Age of Respondents	Frequency	Percent	Age of Respondents
16-25	82	20.5	16-25
26-35	164	41	26-35
36-45	106	26.5	36-45
46-55	41	10.3	46-55
Above 56	7	1.7	Above 56
Total	400	100	Total
Age of Respondents	Frequency	Percent	Age of Respondents
16-25	82	20.5	16-25

26-35	164	41	26-35
36-45	106	26.5	36-45
46-55	41	10.3	46-55

### Occupation of the Respondents

Respondents must convey themselves to places of work and services within or outside their residential area on regular basis. This justifies categories of occupation as a vital factor in choice of reaching and using bus stop facilities in order to accomplish trip purposes. (Table 3) revealed the analysis of occupation of the respondents.

**Table 3:** Occupation of the Respondents

Occupation of the Respondents	Frequency	Percent	Occupation of the Respondents
Civil Servant	100	25	Civil Servant
Student	122	30.5	Student
Unemployed	36	9	Unemployed
Artisan	17	4.2	Artisan
Business	93	23.3	Business
Organized Private Sector			

(Table 3) deducted that 30.5% of the respondents were students, which indicates the peak percentage, while Organized Private Sector have the least with 8%. The motive for using bus stop by the respondent were due to existence of many establishments which include but not limited to administrative, commercial, educational and industrial institutions among others.

### Income Distribution of Respondents

(Table 4) shows that the highest percentage, 53.5% of the respondents earned less than ₦18,000 on monthly basis, while 0.3% of the respondents earn more than ₦201,000 making it the lowest percentage.

**Table 4:** Income Distribution of Respondents

Income of the Respondents	Frequency	Percent
Less than 18,000	214	53.5
19,000-50,000	80	20
51,000-100,000	61	15.2
101,000-150,000	39	9.8
151,000-200,000	5	1.2
More than 201,000	1	0.3
Total	400	100

This denotes that most respondents accessing bus stop were low income earners (urban poor) who may not be able to afford their own automobile. They access the bus stop to board public transit that will convey them to their various destinations. While those respondents earning more than ₦201,000 are high income earners who could afford to own automobiles that can convey them to their destination.

## COMMUTERS PERCEPTION OF ACCESSIBILITY

### Evaluating Means of Accessibility to Bus Stops

The means of accessibility in Kaduna metropolis include walking to the bus stop, the use of motorcycles, taxis, tricycles and buses. The evaluation of the means of accessibility to bus stop was analyzed with cross tabulation and chi-square test.

### Cross Tabulation between Sex of the Respondents and Means Used

Measuring the ease of access to the bus stop is important in evaluating existing services, predicting travel demands, allocating transportation investments and making decisions on land use development. (Table 5) analyzed the result of a cross tabulation between sex of the respondent and means used, means and income and means and fare paid. This was to determine how statistically significant their associations are.

**Table 5:** Cross Tabulation between Sex of the Respondents and Means Used

Sex of Respondents	Means of Accessibility	Frequency	Percent	Sex of Respondents	Means of Accessibility
Male`	Walking	20	9.5	Male`	Walking
	Motor-cycle	50	23.8		Motor-cycle
	Taxi	26	12.4		Taxi
30.5	30.5	30.5	30.5	30.5	30.5

It was revealed that 33% of male respondents used tricycle as a means of transport and 9.5% reach the bus stop through walking. 32.1% of female respondents used bus to reach the bus stop and the least percentage of 10% walk to bus stop. This implies that most female have luggage, goods and children with them when using this means to access the bus stop. Therefore for ease of conveyance they use bus and tricycle most.

### Cross Tabulation between Means of Access and Income

A cross tabulation between means of access to bus stops and income was carried out to as shown in (Table 6).

**Table 6:** Cross Tabulation between Means Used and Income

	Income	Total	19-50	51-100
Means of Access to Bus Stop	Motorcycle	9	1	19
	Taxi	19	0	26

This revealed that all income groups use all the means of accessibility considered as represented across the results on the table. A chi-square test was carried out to know the statistical significance of the association between means accessibility used and income as seen in (Table 7). We can see here that  $\chi(1) = 10.195$ ,  $p = 0.807$ . This tells us that there is no statistically significant association between means of accessibility and income; that is, all income groups equally use the available means of accessibility.

### Cross Tabulation between Means of Accessibility and Fare

A cross tabulation between means of access to bus stops and fare was carried out to as shown in (Table 8).



**Table 7:** Chi-Square Tests for Means Used and Income

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.195a	15	0.807
Likelihood Ratio	11.890	15	0.687
N of Valid Cases	400		

a. 9 cells (37.5%) have expected count less than 5. The minimum expected count is .10.

**Table 8:** Cross Tabulation between Means Used and Fare

		Fare Paid (₦)					Total
		101-150	151-200	51-100	Above 201	Below 50	
Means of Access to Bus Stop	Motorcycle	2	0	50	0	32	84
	Taxi	9	2	82	4	53	150
	Tricycle	9	1	59	0	59	128
	Walking	0	0	10	0	28	38
Total		20	3	201	4	172	400

This revealed that taxi has the highest frequency for those who pay between ₦51-100 and the lowest frequency ₦151- 200, closely followed by above ₦201. We can see here that  $\chi^2(1) = 10.195$ ,  $p = 0.006$  as shown on (Table 9). This means that there is a statistically significant association between means of transportation and fares paid; meaning, the means of transportation used is dependent on the fare charged for it.

**Table 9:** Chi- Square Test for Means Used and Fare

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	32.122a	15	0.006
Likelihood Ratio	35.902	15	0.002
N of Valid Cases	400		

a. 14 cells (58.3%) have expected count less than 5. The minimum expected count is .10.

**Problem Associated with Accessibility of Bus Stop**

In Kaduna metropolis, as elsewhere, transport services are a vital enabler of economic and social activity. They determine peoples' level of access to many other services and thus have a major impact on their quality of life generally. This includes access to work, education, social services, family and friends, leisure, and many other purposes. This section show result of the analysis of problems associated with accessibility of bus stop using cross tabulation and regression analysis.

**Waiting Time at Bus Stop**

An imperative characteristic of a public transport service is the time a passenger has to wait before getting on a vehicle. For this research, waiting time for bus is defined as the time a passenger spent at the bus stop between the passenger's arrival at a bus stop with the intention of catching bus and the time the bus he/she eventually boarded departs from the bus stop. (Table 10) shows

the result of analysis of how long respondent wait at the bus stop.

**Table 10:** Cross Tabulation of Waiting Time at Bus Stop

Age of Respondents	Waiting Time at bus stop	Frequency	Percent
below 25	Less than 5 mins	23	28
	05-Oct	45	54.9
	Oct-15	14	17.1
	Total	82	100
26-35	Less than 5 mins	39	23.8
	05-Oct	58	35.4
	Oct-15	53	32.3
	Above 15	14	8.5
	Total	164	100
36-45	Less than 5 mins	18	17
	05-Oct	19	17.9
	Oct-15	35	33
	Above 15	34	32.1
	Total	106	100
46-55	Less than 5 mins	10	24.4
	05-Oct	6	14.6
	Oct-15	12	29.3
	Above 15	13	31.7
	Total	41	100
Above 56	Less than 5 mins	2	28.6
	Oct-15	3	42.9
	Above 15	2	28.6
	Total	7	100

The average passenger waiting time, the world over as devised by the World Bank, ranges from 5-10 minutes indicating high quality of bus services and the maximum time passengers are expected to wait for the arrival of buses at bus stops, ranges from 11-20 minutes indicating moderate quality of services. When the passengers waiting time is above 20 minutes, it indicates poor quality of bus services (World Bank, 1987). It can be deducted from the table that majority of the respondents especially between 36-55 years age bracket spend between 10- 15 minutes waiting for vehicle. This implies that waiting time for vehicle at bus stop is moderate in the study area. Factors contributing to the long waiting times for bus in these centers, as observed during the fieldwork, include low bus service frequency, low connectivity of bus routes, few economic and social activities going on there and low population and as a result, few bus operators are prepared to carry passengers to such centers.

**Walking Distance from Bus Stop**

The extent by which bus passengers walk before reaching the nearest bus stops to them depends on the spacing between adjacent transit bus routes and the spacing between adjacent bus stops [24,25]. If the total bus services in a place is spread, passenger walking distance should be short and if the bus services are concentrated in few routes that means long walks by the bus passengers [26].

The World Bank (1987) explained that in reasonable well served urban areas, passengers are expected to find bus stop within 300-500 meters from their home or work place. Distance in excess of 500 meters may be accepted in low density area. In a densely populated area like Kaduna it is expected to walk between 300-500 meters to reach bus stop. (Table 11) revealed that most of the respondents trek between 100-300 meters before accessing bus stop while least percentage trek 300 meters and above. This means that commuters walk short distance before reaching the bus stop. The reason is not far from the facts that bus stops are within the residential areas making it easy for commuter to access them. Also commuters make use of the available means of access to bus stops, so they do not have to trek if the area they live is far.

**Table 11:** Cross Tabulation of Walking Distances by Commuters

Age of Respondents	Walking Distance from Bus Stop (meters)	Frequency	Percent
below 25	1-100	20	24.4
	101-200	36	43.9
	201-300	23	28
	301-400	3	3.7
	Total	82	100
26-35	1-100	20	12.2
	101-200	46	28
	201-300	70	42.7
	301-400	28	17.1
	Total	164	100
36-45	101-200	22	20.8
	201-300	25	23.6
	301-400	59	55.7
	Total	106	100

46-55	101-200	14	34.1
	201-300	8	19.5
	301-400	19	46.3
	Total	41	100
above 56	101-200	4	57.1
	201-300	2	28.6
	301-400	1	14.3
	Total	7	100

**Respondents Problem of Accessibility to Bus Stop**

The nature, type of transport services and location of bus stop have significant environmental implications as well as overall accessibility and patronage level of public transport services. (Table 12) shows the result of cross tabulation between sex of respondent and problem associated with accessibility of bus stop.

**Table 12:** Problems Associated with Accessibility to Bus stop

Gender of Respondents	Accessibility Problem	Frequency	Percent
Male	Long walking distance	59	28.1
	High fare	50	23.8
	Long waiting time	66	31.4
	Insufficient bus at bus stop	31	14.8
	Other	4	1.9
	Total	210	100
Female	Long walking distance	40	21.1
	High fare	60	31.6
	Long waiting time	49	25.8
	Insufficient bus at bus stop	39	20.5
	Other	2	1.1
	Total	190	100

Passengers' walking distance from origin or destination to the nearest bus stop is one of the important elements that determine the accessibility of transport services in any given urban area. Walking distance of a bus passenger can be defined as the distance passengers walk before reaching the nearest bus stop from origin or destination to catch bus services. The table shows that 31.4% of the male respondents were of the opinion that long walking distance is the major problem in accessing bus stop. The female have a contrary opinion, 31.6 % of them indicated that high transport fare is the problem they face in accessing bus stop.

**CONCLUSION**

This research addresses the unmet need for a better measure of accessibility that has a more generalized approach responsive to the transit needs of the commuters. A vast majority of researches rely solely on socioeconomic characteristics and commuters perceptions to analyze accessibility. It is quite necessary to determine the socio-demographic characteristics as well as the

commuters' perception because not everything about accessibility can be physically measured. The variables considered in this study are an effective way to measure accessibility to bus stops. However, going further other physical measurable indices are recommended to measure accessibility. The use of geographical information system can be utilized to achieve this.

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