

CORRELATES OF PUBLIC TRANSPORT DEMAND IN LAGOS METROPOLIS

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Abstract

Studies have shown that the public transport demand in urban areas are mainly determined by interrelated trends, significant among which are the population characteristics such as car ownership, household size, income and occupation, as well as travel purpose, distance, frequency, speed, cost, comfort and traffic volume. Given the fact that there exist dominant focus and differences in public transport supply in terms of technical efficiency and production cost of facilities between the case studies, the study therefore examined the relative importance of the population characteristics in the determination of public transport demand in Lagos metropolis. A total of 1,351 households were selected and structured questionnaire administered on heads of the households using multi stage sampling technique. Data analysis was descriptive (frequency, mean) and inferential using stepwise and non-stepwise regression analyses. The findings revealed that the most important determinants of public transport demand were travel cost ($R^2 = 0.433$, $p < 0.05$), household income ($R^2 = 0.206$, $p < 0.05$) and car ownership ($R^2 = 0.010$). The transport cost and household characteristics including income per month and car ownership significantly determine variations in public transport demand of various population density zones in Lagos metropolis. Therefore, it is recommended that level of transport cost charge by the operators and improvement in income of users should be considered in any policy framework for public transport services in urban areas, especially in Lagos metropolis.

Key Words: Public Transport, Demand, Household, Attributes, Lagos

Introduction

Determination of the factors that influence the demand for public transport in a metropolitan area is basic necessity for planning of the public transport system of such an urban area. There is a need for public transport planners, engineers and policy makers to know what these factors are; and to know how public transport demand vary between different density areas, types of transport services provided, types of journey made and purpose

(Balcombe *et al.*, 2004). Furthermore, studies have shown that residential density changes, car ownership, public transport accessibility and income patterns all affect the demand for public transport (Bowman and Ben-Akiva, 2000, Balcombe *et al.*, 2004, Espino *et al.*, 2007). The importance of this knowledge in the routing, scheduling and general planning of public transport system cannot be overemphasized.

The public transport system facilitates the alleviation of spatial inequality and in improving social interaction. At economic level, an adequate and efficient public transport system plays a key role in the development of a city's economy, transforming local markets into national, regional and global markets. It also facilitates the attainment of the economy of scale in the production of goods and services and the generation of new employment opportunities (LASG, 2007). Transportation systems are essential to overcome the friction of distance and provide the freedom of access necessary to enjoy the several quality of life related opportunities distributed throughout metropolitan areas. Access to employment, commerce, housing, recreation, etc., are representative of those amenities of life that transportation systems must provide in both an effective and efficient manner (Badejo, 2009). Not only does the transportation system provide for the mobility of people and goods, but also influences patterns of growth and economic activity through accessibility to land.

Public transport is often seen as a system whereby passengers and goods services are mostly provided by public carriers. This is more so because any other type of transport not licensed as stage carriage is often regarded as private or personal transport. This view suggests the focus of the study because public transport remains a major growth sector in cities of most developing countries. According to a World Bank publication, the demand for public transport services is growing steadily in the large cities of the developing world (Fox, 2000). This fact is very noticeable along the transport corridors linking the ever-expanding sub-

urban areas to main employment zones of the cities, particularly to the city centres.

In city development, recent studies on urban transportation focused more on transportation service supply with little or no attention on service demand. For instance, Brueckner and Selod (2006), Roy and Yvrone-Billon (2006), Farsi, Fetz and Filippini (2007), Fernandez, de Cea and Malbran (2008) focused mainly on the technical efficiency and production cost of facilities as determinants of public transport supply. While some few studies contested that price and time elasticity as well as modal choice in relation to the population must be considered in public transport demand to sustain its supply (Dargay and Hanly, 2002; Matas, 2004; Garcia-Ferrer *et al.*, 2006). Given the fact that there exist dominant focus and differences in public transport supply in terms of technical efficiency and production cost of facilities between these studies, the research problem is to examine the extent to which the population characteristics such as car ownership, household size, income and occupation, as well as travel purpose, distance, frequency, speed, cost, comfort and traffic volume determine demand for public transport. Such demand information along with the existing supply factors will ensure sustainable public transport system. It is therefore the aim of the study to examine the population characteristics in the determination of variations in public transport demand in different residential density areas of Lagos metropolis.

Literature Review

In a study investigating the relationship between density and public transport, Cervero and Guerra (2011) deduce that four characteristics have been found to stand out as explanations of transportation differences, namely income which is a function of vehicle ownership

and development of road infrastructure; City size and size distribution which affects length of commuting, the level of traffic congestion and the environmental impact of road traffic; political history which reflects transition between socialist planned cities that have dispersed pockets of high-density residences served by mass transit; and those cities where market forces played a greater role in shaping land use and population growth rates which lead to congestion and high demand for mobility and car ownership. Abstracting from the issue of city size, they give taxonomy of city types into which major cities can be divided but which to some extent explains the type of public transport systems that they have acquired. According to the World Bank (2002), where population growth has been slower, and particularly for the cities in formerly centrally planned economies that have suffered stagnating incomes, the probability of there being mass transit systems is greater than income alone would suggest.

Also, according to Cervero and Guerra (2011), travel time, routes, modes and speed are inputs to urban transport system that determine are the movements of person and goods between urban activity centres. The outputs of the movements include the spatial patterns of travel demand that exists throughout an urban region and the times throughout the day at which the dominant spatial patterns of demand occur. The travel times are the major output of the movement and the magnitude of this output variable depends on the size of the travel demands and the capabilities of various links of the network. Urban transport system also produces indirect (or secondary) outputs such as the impacts that the transport system has on the spatial distribution of

urban activities. However, human movements in urban areas are made up of a number of different trip types that have specific spatial and temporal characteristics. In urban transport analysis, the trip types studied in a particular area depend on the types of transport planning issues at hand.

In transport modelling a trip is usually defined as a single journey made by an individual between two points by a specified model of travel and for a defined purpose (Bowman and Ben-Akiva, 2000; McGuckin and Nakamoto, 2004). There are two types of trip, namely, Home-based trips and Non-home-based trips. Home-based trips are those trips that have one trip end at a household and these include work trips, schools trips, shopping trips, personal business trips, and social-recreational trips. According to Solanke (2005), urban travel is dominated by journey to work in smaller cities of less than 200,000 populations. Non-home based trips are those trips between attracting land uses, examples are work to a restaurant, shopping to cinema, business trips between two places of employment, work to shops and so on. The basic characteristics of these trips are the access time from point of origin to boarding point, waiting time-at bus stop and time spent in travel.

According to the findings of Taylor *et al.* (2003), the main factors influencing public transport demand include urban structure; socio-economic characteristic of the urban dwellers; travel behaviour and available transport facilities. Arguably, the factors vary from city to city because of time of development, facilities available and nature of economy. This therefore means that there is need to examine their relative effects in different cities. Fares are also fundamental to

operation of public transport since they form a major source of income to operators. According to the findings of Paulley *et al.* (2006), if fares are increased, patronage will decrease in public transport in Great Britain. They maintained that fare elasticity are dynamic, varying over time for a considerable period following fare changes for different trip purposes, types of traveller and the distance travelled. Furthermore, Paulley *et al.* (2006) observed that quality of service which can be defined by wide range of attributes like access time, vehicle characteristics, service reliability etc, also affect public transport demand which vary from economy to economy and time.

Hensher (2008) investigated the causal relationship between public transport demand and the service level using a Granger-causality test in Swedish counties for the period 1986 - 2001. It is concluded that while vehicle-kilometres is found to cause number of trips made, the number of trips also causes vehicle-kilometres. Hence, there is a two-way relationship between these variables. Also, Meta-analysis of public transport demand has shown that fare, level of service, income, price of petrol and car ownership, respectively and separately are the determinants of local public transport demand elasticity (Holmgren, 2008). In addition, Holmgren (2008) acknowledged the fact that differences between countries and time – series have effects in estimating a demand function for local public transport. The study showed that demand elasticity with respect to public transport fare, price of petrol, vehicle-kilometres and car ownership are found to be -0.4, 0.34, 0.55, and -1.37 in Swedish counties. Also, the study found that the strong increase in public transport demand in the town of Linköping between 1946

and 1983 can be explained by the rapid increase in female labour force participation. Furthermore Johan *et al.* (2008) analysed that the effects of a policy change, like peak-load pricing, straighter bus routes, smaller bus size and staggered school hours, led to increase in public transport travel by 42% in Sweden. Therefore, for adequate public transport policy, there is need to review the drivers of public transport demand by analysing the population, transport options and prices (Todd, 2013).

Study Area

The study is set in the Metropolitan Lagos within Lagos State; south western Nigeria (Fig.1). The study area comprises the 16 urban local government areas that make up the Metropolitan Lagos. The constituting LGAs are Apapa, Ajeromi Ifelodun, Alimosho, Agege, Ifako Ijaiye, Ikeja, Somolu, Eti Osa, Oshodi Isolo, Amuwo Odofin, Kosofe, Ojo, Mushin, Lagos Mainland, Lagos Island and Surulere Local Government Areas of Lagos State.

Lagos is the most populous conurbation in Nigeria with 1991 and 2006 census population figures of 5,294,774 and 7,937,932 respectively, for Metropolitan Lagos and 2012 projected population figure of 9,384,830 at annual growth rate of 5.8% (LSDS 2006, NPC 2006). Presently, 2019 population projection of Lagos based on annual growth rate of 5.8% is 13,925,990. Estimates of transport demand in Metropolitan Lagos in 1990 ranged from 7 million to 10 million passenger trips daily, of which over 95% were undertaken by road, primarily by private cars, buses and taxis. Of these, between 80% and 85% were made by public transport. Lagos commenced the operations of a bus rapid transit system in 2008 which was planned

to operate along eight routes using peculiar nature of this transport demand
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lanes running through the city. The Metropolis for the study.

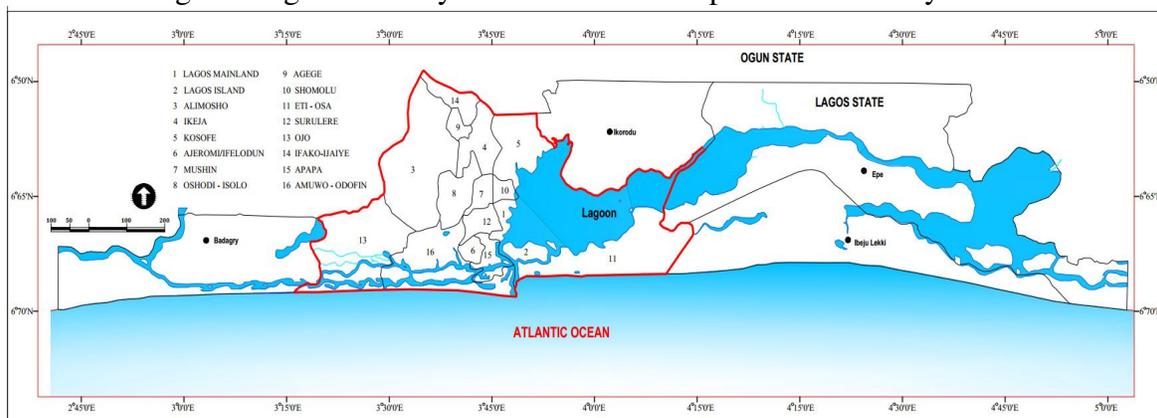


Fig.1 Metropolitan Lagos in Lagos State

Methodology

To examine the correlates of public transport demand in Lagos metropolis, questionnaires were administered on 1,351 households from the total 1,443,820, representing a sample ratio of 0.09%. Using the multi-stage sampling technique, the 16 Local government areas of Lagos metropolis were first identified and classified into high, medium and low density residential zones. Major wards in each of these local government areas were selected in the second stage by simple random sampling while in the third stage streets were selected in the chosen wards based on their grades in terms of paved and unpaved streets. Every third housing unit was then systematically selected in each of the streets for questionnaire administration on the households' heads. Table 1 show the sampling procedure and sample size distribution.

Data collected include the socio-economic characteristics of the households, which include the gender,

marital status, age, level of literacy, employment status and type, level of income, place of work, household size and access to telecommunication facilities. Also collected were data on public transport demand characteristics which include private vehicle ownership, level, type and frequency of public transport usage, factors determining public transport usage, origin, destination, purpose, length, duration, mode, cost and frequency of public transport usage as well as the level of frequency, affordability, satisfaction, service rate. In addition, data on the public transport system characteristics which include travel diary of the household, average waiting time, assessment and prioritisation of such indices as journey time and speed, comfort, cost, safety from crime and safety from traffic accidents were collected.

The data collected for this study were analysed using descriptive technique (frequency, mean, standard deviation) and inferential using regression analysis.

Table 1.Sampling procedure and sample size distribution

Density class	L.G.A	Total households	Total Wards	Selected Wards	Sampled Households
High density	Agege	83,658	11	3	70
	Ajeromi-Ifelodun	124,431	11	2	143
	Alimosho	232,402	11	3	228
	Oshodi-Isolo	113,045	11	3	34
	Ifako-Ijaye	77,826	11	3	86
	Kosofe	121,027	10	2	140
	Mushin	115,137	14	3	132
	Ojo	108,782	11	3	76
	Shomolu	73,242	12	3	68
Medium Density	Lagos Mainland	57,790	11	3	63
	Apapa	39,536	10	3	45
	Amuwo-Odofin	57,871	11	3	60
	Surulere	91,667	12	3	70
Low density	Eti-Osa	52,345	10	2	47
	Ikeja	56,967	10	3	38
	Lagos Island	38,094	20	5	42
TOTAL		1,443,820	186	47	1351

Results and Discussion

The data were descriptively analysed and later subjected to inferential analysis using regression technique in order to determine the factors of the public transport demand. Public transport demand is measured by the number or frequency of trips made using public transport vehicles. The study revealed that 91.6% of the respondents used public transport and 53.7% used between 1 – 3 vehicles daily for the travel. From the data obtained, public transport usage is prevalent in all the density zones especially in the high density. However, in all the density areas, an average of 48.3% of the respondents use the public transport every day, 17.2% of the respondents rarely use the public transport, 15.8% use it only on working days and 6.1% use it weekly. Therefore this study examines the factors responsible for the variation in the usage. The factors considered include the length

of distance travelled, the travel cost, trip purpose, travel mode, travel time and socio-economic characteristics of the users such as age, gender, income and car ownership.

Because of the complexities and uncertainties involved in the determination of distances travelled by the respondents, data on the length of journey made by the respondents was obtained by determining the shortest linear distances between all the LGAs headquarters in Metropolitan Lagos. Analysis of the total length of journey made on public transport modes by respondents in all the density areas show that about 28% travel between 11 kilometres and 20 kilometres, while 23% make a total journey length of between 21 kilometres and 30 kilometres. About 17% travel less than 10 kilometres. It is therefore important to understand how the differences in the distances travelled affect the demand for public transport.

In all the three density areas, an average of 48.3% of the respondents spend less than \$1 per day, 23.7% spend about \$2 per day, 6.7% spend \$3 per day and 5.8% spend more than \$3 per day while 15.5% did not respond, indicating demand for non-motorised system of transport. The average cost of public transport users per day in Metropolitan Lagos is more than \$2 however; public transport users in low income areas (ie High density zone) spend less than \$2 because they mostly make use of intra-transport system within their locality which is not too far from their locations.

Trips for work purposes showed that average of 40.9% are made on public transport; with 38.4%, 44.8% and 38.3% in the high, medium and low density areas as work related trips respectively. Further trip purposes in all the density areas are social, shopping, education and leisure, representing 12.8%, 12.4%, 5.0% and 4.7% of the responses, respectively. Only 2.6% of the responses are for religious purpose and other purposes represent 0.3% while none response is 21.5%.

The types of public transport vehicles used include the bus rapid transit, boats, *danfo* buses, coaster buses, *molue* buses, motorcycles, private cars, taxis, tricycles and walking; with *danfo* buses (52.3%) being the dominant use. Private car, motorcycle, bus rapid transit, *molue*, tricycle, walking, taxi and boat proceed respectively.

Data on travel time showed that 64.3% of the respondents spent average of less than 5 minutes in waiting; 25.6% spent between 5 and 10 minutes while 7.2%, 1.9% and 1% of the respondents spent between 10 and 20 minutes, 20 and 30 minutes and more than 30 minutes, respectively.

Socio-economic characteristics revealed 38.5% the respondents between 25 and 34 years, use public transport in all the density zones. Also, 24.3%, 22.7% and 10.2% are within the age bracket of 35- 44 years, 15 – 24 years and 45 – 54 years respectively while 3.2% and 0.4% are less than and above 65 years respectively. In all the density zones, 60.3% of the public transport users are males and 39.7% are females. Income per month of the respondents showed that 15.5%, 13.4% and 11.6% earn between \$50 and \$100, \$100 and \$150 and below \$50 respectively while 15.4% earn less than \$250 and 7.8% earn above \$250 per month. The car ownership showed that 52.9 of the respondents do not have vehicles in all the households in the density zones. This implies that the households rely more on the public transport. Only 27% of the respondents have one vehicle per household, 10.9% have 2 vehicles, 4.7% have 3 vehicles and 2.3% have 4 vehicles.

To examine correlates of public transport demand factors, regression analysis technique is applied. The dependent variable is the public transport demand, PTD, measured by the number of trips made, while the independent variables are the length of journey, LJ (distance in kilometre), transport cost, TC (amount of money), trip purpose, TP (1 = working, 0 otherwise), trip mode, TM (1 = *danfo*, 0 otherwise), waiting time, WT (number of minutes) and the socio economic characteristics such as income, IN (amount of money per month) and car ownership, CO (number of vehicles owned). The relative importance of each variable is determined by the R^2 change, which shows individual contributions to the overall explained variance, as presented in Table 2.

The most important variable that determines the demand for public transport is the transport cost (TC). The TC is significant and accounts for 43.3% of public transport patronage. The TC coefficient shows that a unit increase in transport cost would result in 0.494 decreases in number of trips made using public transport. This is supported by the findings of Paulley *et al.* (2006), Holmgren (2008) and Todd (2013) that if fares are increased, patronage will decrease in public transport.

The second most important variable is the Income (IN), which is also significant and accounts for 20.6% of the public transport patronage. The IN coefficient means that a unit increase in income per month which will encourage car ownership would result in 0.286 decreases in number of trips made using public transport. This assertion is supported by the findings of Espino *et al.* (2007) and Todd (2013). The survey even showed that 40.5% of the households that do not have cars earn less than \$150 per month and mainly use public transport.

The next variable in order of importance is car ownership (CO), which accounts for only 1%. The CO is significant and its coefficient shows that a unit increase in the number of cars owned would result in 0.197 decreases in the use of public transport. After the third step, the other four variables are not significant and important in the determination of public transport patronage. This is because each of the variables accounts for less than 1% of the demand for public transport.

The final regression model for this analysis is given as:

$$PTD = a + TC + IN + CO + e \dots\dots\dots 1$$

Where PTD = Public Transport Demand
 a = constant, TC = Transport cost, IN = Income, CO = Car Ownership, e = error term.

The stepwise regression analysis has shown that the significant determinants of public transport demand are the transport cost, income and car ownership. This however has been corroborated in the past studies. Therefore, the important determinants of public transport demand in Lagos metropolis include the transport cost, income and car ownership.

Table 2: Stepwise Regression Analysis: Public Transport Demand Determinants

Step	Variables	Multiple R	R ²	R ² change	Coefficient	t-value	Sign. Level
1	TC	0.623	0.433	0.433	-0.494	-7.646	0.000
2	IN	0.673	0.639	0.206	-0.286	-4.944	0.000
3	CO	0.681	0.649	0.010	-0.197	-3.542	0.001
4	LJ	0.689	0.655	0.006	-0.119	-3.006	0.025
5	WT	0.704	0.660	0.005	-0.117	-3.001	0.035
6	TP	0.723	0.664	0.004	0.111	3.107	0.027
7	TM	0.729	0.667	0.003	0.010	2.019	0.031

F- value = 66.827

Conclusion and Recommendation

This study has examined the correlates of public transport in Lagos Metropolis in order to determine their relative importance. In doing so, attempts were made to examine the public transport

services, the travel characteristics of the users and their socio-economic status. The analysis revealed that the transport cost and socio-economic characteristics such as income per month and car ownership significantly determine the demand for

public transport usage in Lagos. It is therefore recommended that appropriate policy should be made to enhance transport facilities in order to regulate transport fares and improve the socio-economic conditions of the users to encourage patronage for public transport. The policy option is to make public transport available and affordable through regulatory measures that will take into consideration the identified demand factors in Lagos Metropolis.

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