

Analysis of effects of prolonged travel delay on public bus operators' profit margin in metropolitan Lagos, Nigeria

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Abstract: This study examines the effects of uncertain travel time on public bus operators' monthly returns or profit margin in metropolitan Lagos, Nigeria. Importantly, the study relied on four objectives to achieve its purpose, and these are to; evaluate the demographic profile of public bus drivers; determine the daily cost of operating the buses and the percentage of bus returns spent on bus maintenance; analyze the bus running time and the associated cost attached to prolonged bus operations, and determine the number of trips made and lost daily due to prolonged journey time in metropolitan Lagos. The study relied on a survey research design and the use of primary data, which is derived from a questionnaire instrument administered at the three study locations. Further, the combination of clustered, stratified, and simple random sampling techniques was used while respondents (bus operators/drivers) were selected at different bus stop segments for questionnaire administration. The statistical correlation technique from the SPSS software was used for data relationship analysis, while descriptive tools were utilized for the presentation of the results. Furthermore, the severity of the problems encountered by bus operators shows that loss of daily revenue (52.9%) is the highest, followed by loss of bus trips (35.4%), and constant vehicle breakdown (11.7%). This poses a significant challenge to their business success as it grossly reduces their bus return and monthly profit margin. The study concluded that prolonged bus journey time has a negative socio-economic impact on the Intra-City public bus operators in metropolitan Lagos. Therefore, recommends among others: road highway expansion; provision of extended bus stop lay-bys, BRT corridor extension to other major highways, traffic agents' commitment and patriotism, and intensive enforcement of laws prohibiting bus stop obstructions by public bus drivers.

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Keywords: intra-city, prolonged travel delay, bus stop, fuel cost, operators' profit margin.

1. Introduction

Arterial roads or Highways are any public way on land, or the main road that connects cities, towns, and places of industrial and commercial prominence for mass exchange of goods, and services by providing access for free flow (instead of the restricted streets' traffic) of buses, trucks, motorcyclists, bicycles, and pedestrians including the physically challenged within a transport system. Arterial road infrastructures play important roles in traffic flow efficiency, public bus operations, and travel time reliability. They also play a vital role in the socio-economic and political development of countries. Public bus operations involve the activities of commercial buses aimed at providing smooth and affordable mass transit services across the city sphere to discourage personal car usage. The effectiveness of public bus operations and importantly, travel time reliability in Nigeria and metropolitan Lagos, in particular, have been observed to rely on the quality of route structure or road geometry. Low-capacity highway infrastructures will result in reduced flow, prolonged delay, and increased travel time uncertainties. The total travel time is dependent on the interactions of vehicles with the road infrastructure and the understanding of how time is utilized and lost during public bus operations is crucial for planning just in time public bus transport services in metropolitan Lagos. (Ogwude, 2016; Gupta, 2014; Mushule, 2012; Martin, Abdul-Aziz, Annin & Oduro, 2013; Lee, & Liu, 2014; Wei, 2014; Chowdhury, 2016; Odeleye & Oni, 2007; TRB, 2013; Ibrahim, 2010).

Travel time reliability (TTR) is one of the most important factors in travel behavior. It reflects the level of uncertainty experienced by travelers in their movement between origin and destination or between any two nodes along with a network of travel. The importance of travel time reliability depends on the penalties incurred by the travelers. In road networks, travelers consider the existence of a trip travel time uncertainty in different choice situations such as departure time, route to follow, mode selection, period of the day, congestion level, and others. Studies on Public Bus travel time reliability have been gaining more recognition due to its importance as a key performance pointer to the efficiency of roadways and transport systems in recent times. More so, in Nigerian cities, most commuters are less tolerant of unexpected delays because such delays have marginal economic consequences on them than the bus operators (Olorunpomi, 2010). This means that transport infrastructures have consequential effects on public bus travel time and passenger utility maximization. Hulten, (2004); Oni and Okanlawon (2008); Nworji and Oluwalaiye, (2012); Gbadamoshi and Ibrahim, (2013); Ali, Barra, Berg, Damania, Nash, and Russ, (2014), all testify to the significance of transport infrastructures in public transit efficiency.

In practice, many factors affect bus travel time, its variability, and reliability. These include uncertain passenger demand; low highway infrastructure capacity; low capacity bus stop lay-bys, inappropriate bus stop locations, bus dwell time, turning delay; interchange and signalized intersection delay, traffic conditions, drivers' behavior, payment types, vehicle incidents/accidents, weather condition, construction activity and others (Wei, 2014; Chen, Zeng, Chen, Yu & Wang, 2018; Oni, Olorunnimbe, Ege & Giwa, 2018). Importantly, the daily congestion being experienced especially by public buses is discouraging for commuters (captive riders) who are forced to pay higher fares to reduce the extra cost imposed on public bus operators by congestion. Therefore, if the impacts of fixed, operational, incident/accident and construction delays and public bus travel time distribution along bus stop segment level can be quantified, researchers, transit operators, planners, and infrastructure providers can prioritize investments or provide measures that will tackle the main sources of congestion and travel time uncertainties to ensure just-in-time arrival prediction and discourage personal automobile usage. It is towards achieving the highlighted benefits that this study intends to analyze the Intra-City public bus travel time reliability along arterial roads in metropolitan Lagos.

1.1. Statement of the research problem

Public bus travel time reliability serves as a significant measure for evaluating the operational efficiency of transportation facilities and bus services, thereby delivering travelers with timely and

reliable route information. The US TRB (2013); US DOT, (2014); Zeng et al., (2015); Yashaswi & Srinivas, (2016); Zhang et al., (2017); and Ji, Ban, Zhang, & Ran, (2018) have confirmed that all over the world, (especially in the USA, China, England, Australia, Qatar, South Africa, and others) transit agencies make every effort to reduce bus travel time and its variability. This is because commuters want a reliable travel time, that is, a consistency in travel times on all days while the operators also want a situation where a trip will take 1hour today, 1hour tomorrow, and every other day.

However, achieving this consistency and reliability in the public transport sphere in Nigerian cities has been a problem. This is because public bus operation in Nigeria and metropolitan Lagos, in particular, is dominated by road mode and the yellow commercial buses constitute the largest operators in the metropolis. The yellow bus services are largely unorganized in structure, bedeviled with infrastructure inadequacy, incessant congestion, unreliable peak hours travel time, lack of scheduled services, and are being largely driven by mini-buses with attendant periodic price hikes and poor service quality. The records of LAMATA (2016) and the Lagos Bureau of Statistics (2016) revealed that the Bus Rapid Transit (BRT) carries less than 2% while the yellow buses transport more than 44% of daily passenger's demands (To show their importance) in metropolitan Lagos.

Importantly, the majority of passengers in metropolitan Lagos concentrate on the yellow buses for day to mobility services. Moreover, the journey times of the yellow buses are unpredictable and this makes their travel times unreliable especially along Ikorodu, Oshodi-Abeokuta, and Lekki-Ajah expressways (three of the five major arteries within metropolitan Lagos with recurrent congestion and substantial daily operations and freights transfers which made them selected for this study). Such recurrent delays may have un-assumed negative effects on both passengers' and operators' monthly income. Towards ensuring on-time arrival at destinations, commuters tend to leave home too early to work, as early as 4:00 am to add enough buffer time to their journey to avoid getting late to work within metropolitan Lagos as there are no data on daily travel time reliability index and the actual time that must be planned to ensure daily travel reliability within the metropolis. The bus operators do not know when they will arrive at their destinations and therefore strive to increase the transport fare to make up for the time lost to the prolonged travel time along their journey to various destinations. It is the intent of this study to fill this gap.

This study will therefore provide answers to the following research questions: what is the demographic profile of public bus drivers in metropolitan Lagos?; what is the daily cost of operating the yellow buses and the percentage of bus monthly returns spent on bus maintenance?; what are the associated cost attached to prolonged bus operations? and what is the number of trips made and lose daily due to prolonged bus journey time in metropolitan Lagos?.

1.2. Statement of hypothesis

Hypothesis Ho₁: there is no significant correlation between travel time uncertainty and yellow bus operators' monthly profit margin in metropolitan Lagos.

1.3. Study area

Geographical and demographic setting

Metropolitan Lagos is located at the center of Lagos State (fig. 1.0). Lagos State is one of the smallest of the 36 states in Nigeria. located on the south-western corner of the Guinea coast of the Atlantic Ocean for over 180km. Lagos State lies between latitude 6°2' - 6°4' north, and longitude 2°45' - 4°20' east. It occupies a total geographical area of about 3,475.1km². Metropolis of Lagos is home to 85% of the State's population (18.03M out of 21.9M people) with an annual increase of 3.2 percent (Lagos bureau of statistics, 2014). From the growth rate of 3.2%, Lagos population is estimated to be 21.2M, 21.88M; 22.58M; 23,31M; 24.05M and 24.82M people in the year 2012; 2013; 2014; 2015; 2016 and 2017. However, the metropolitan population is estimated to be 21.1M people in 2017. This means that the urban population of Lagos is increasing geometrically (24.7M people in 2022) and therefore transport infrastructures too must be provided with geometrical momentum to cater for the high volume of travel demand and the increasing number of vehicles (from 32,041 vehicles in the year 2000 to 304,935 vehicles in 2015 and 319,500 in 2021 been added to Lagos vehicle fleets annually). Lagos now has over 1.6M vehicles on its road 1n 2021 (MVAA, 2022)

1.3.1. Commercial activities and road passenger traffic in Lagos Metropolis

Lagos State is estimated to account for 90 percent of Nigeria's foreign trade, controls about 80 percent of the total value of the imports of the country, and about 70 percent of the national industrial and commercial investments are in Metropolitan Lagos (LBS, 2016). This means that the city needs an efficient public transport system. Currently, road transport dominates the transportation of people, goods, and services (Table 1) as well as the commercial and social functions in the city.

Table 1: Dominance of Danfo buses in public transport ridership share compared to other modes in Lagos

S/N	Mode	No. of Passengers/Day	Percentage of Total
1	Walking	8,800,000	40%
2	Bus rapid transit	90,000	0.41%
3	Regulated bus (LAGBUS)	150,000	1%
4	Private car	2,508,000	11%
5	Semi-formal Mini Buses (Danfo)	9,982,000	45%
6	Federal Mass Transit Train	132,000	1%
7	Water Transport System	74,000	0.34%
8	Other non-data Modes (including motorcycle, tricycle, taxi, bicycle, articulated vehicles, mini-vans, and boats)	264,000	1%
9	Total passengers' traffic per day	22,000,000	100%

Source: Lagos Metropolitan area transport authority (LAMATA), 2016

Records from the Lagos Bureau of Statistics (2016) and LAMATA (2016), show that the total number of registered buses in Lagos state between 2005 and 2015 is 287, 421. Out of this number, 280,576 were mini-buses and 6,845 were high-capacity buses. Importantly, Commercial minibusses that sustained public transportation in metropolitan Lagos are over 145,000 while high-capacity buses are 1,034 as shown in table 1.0. Also, public buses moved over 46% of the daily road traffic passengers in the Lagos metropolis and are responsible for the mobility of 10,220,000 commuters daily.

1.3.2. Road transport infrastructures and vehicular traffic along with study locations

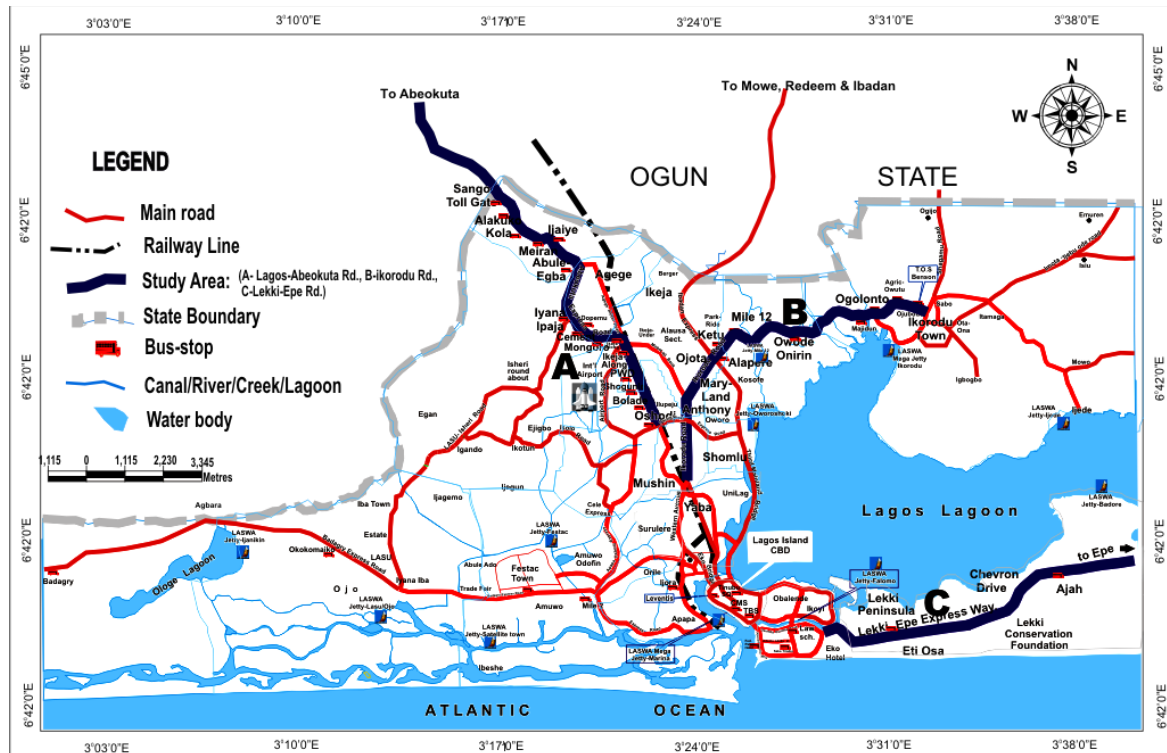
Lagos State has about 2,600 km of roads which are frequently congested with over one million vehicles daily. It has over 30 percent of the total vehicles in Nigeria and the highest vehicular density (264 vehicles/km) as against the national average of 11vehicles/km (FMWH, 2013; LAMATA, 2015; LMOT, 2016; In Metropolitan Lagos, it is very difficult at present to predict travel time where the average journey to work along its highways is over one hour (Oduwaye, Alade & Adekunle, 2011). Importantly, Ikorodu Road, Lagos-Abeokuta and Lekki-Epe Expressways are three (3) major highways with multi-lane dual carriage, carry predominant heavy vehicular traffic, and connect important locations in metropolitan Lagos (Fig. 1).

Firstly, Ikorodu road (labelled as B) is one of the most important arterial links within the Lagos metropolis which links the peripheral settlement of Ikorodu to Lagos Island and other intermediate settlements. Currently, the road is ten (10) lanes with each direction having five lanes (comprising of two speed-lanes, two service lanes, and one dedicated lane for BRT) from Mile 12 to Jibowu and six lanes from Ikorodu to Mile 12. The length of the Road is 24.9km starting from Jibowu to Ikorodu round it has 12 hours traffic volume of 117,202 vehicles and an hourly vehicular volume of 9775 vehicles which made it one of the highways with extreme congestion in metropolitan Lagos. Bus operation along this road is saddled with lots of challenges due to inadequate capacity and absence of required size bus pads/lay-bys; and motor parks. The average peak period travel time on this road is 50 minutes while the off-peak is 22 minutes (in 2007) but currently, the peak period travel time is 1hour 10 minutes, while the off-peak is 33minutes (3-day reconnaissance study by the author, 2019).

Secondly, the Lagos – Abeokuta highway (labeled as A) is another major arterial road in metropolitan Lagos. It is a dual carriage road belonging to the Federal Government (LMOT, 2016). The length of the road is 23.3km starting from Oshodi to Sango-Ota overhead bridge and the inadequate road capacity, absence of extended lay-bys; lack of actuated traffic signals, overhead bridges, and motor parks

are some of the causes of traffic gridlock on this road. This road has a 12-hour traffic volume of 96, 971 and an hourly volume of 8,081 (LAMATA, 2015) which made it one of the major highways in Lagos with extreme congestion. The journey at peak period on this road is 1hour 42 minutes, while the off-peak is 45minutes making the road the worst in travel time among the network studied.

Figure 1: Metropolitan Lagos Showing the Study Area (A, B & C) and Other Road Highways



Source: modified from LAMATA, 2015.

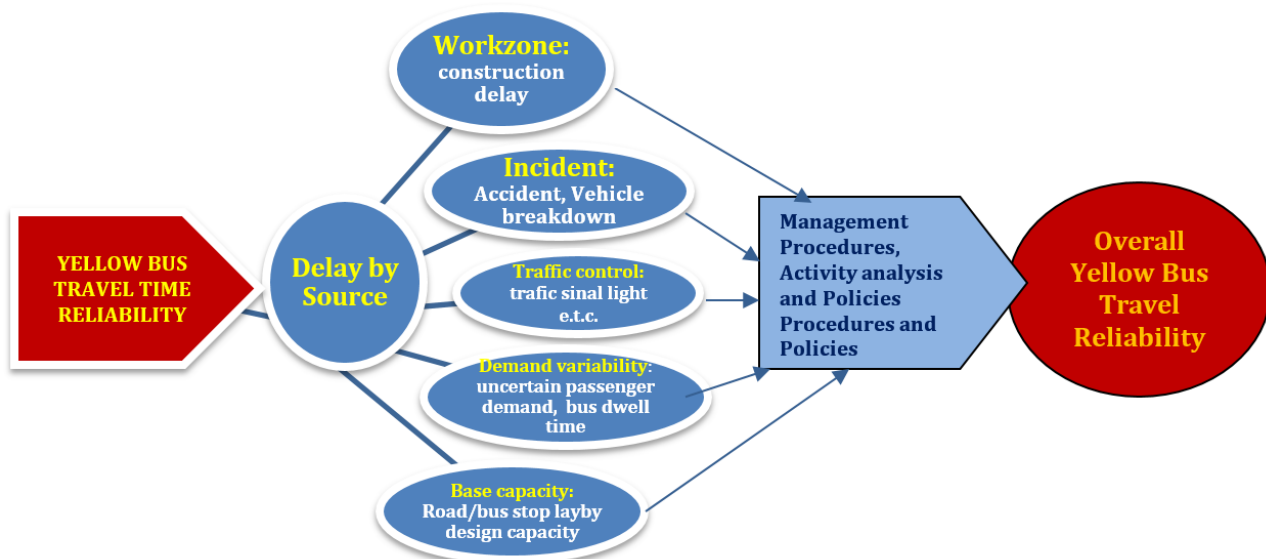
Thirdly, Lekki-Ajah express road (labelled as C) is an important link that connects central Lagos to the important settlement functional area in the eastern part of Lagos. The road has been conceded to the Lekki Concession Company for development and management. The road is 19.7km from Ozumba Mbadiwe to Ajah Bridge and 22.2km in length from Marina bus park. It has six lanes with three lanes in each direction. The road has a 12-hour traffic volume of 23,790 and an hourly volume of 1,982 at the Ozumba Mbadiwe segment (LAMATA, 2015) Currently, the journey at the peak period on this road is 1hour and 5minutes, while the off-peak journey is 36minutes (3-day reconnaissance study by the author, 2019).

2. Conceptual and literature consideration

2.1. Concept of travel time reliability

Bus travel time is defined as the time needed by a bus to travel between two points along a route. (Wei, 2014). Travel time reliability (TTR) is defined as the consistency in travel time over periods of the day or days of the week (Chen, et al., 2018; Etienne, Nicolas & Ludovic, 2015; Ji et al., 2018; Zhang et al., 2017). This concept serves as a significant measure for delivering travelers about reliable route information, evaluating the operational efficiency of transportation facilities, and comparing different traffic management strategies (Chen, Sun, & Qi, 2017a; Ramezani & Geroliminis, 2015; Chen, Zeng, Chen, Yu & Wang, 2018). In metropolitan Lagos, public bus travel time is presently unreliable and travelers have challenges getting to their destination on time. This study, therefore, adopts this concept as part of the basis for examining the travel time reliability of yellow buses in the study area.

Figure 2: Research conceptual framework



Source: Modified from USDOT, 2005; Chen, Yu, Chen and Wang, 2017; Uchida and Kato, 2017.

2.2. Highway infrastructure and effects on public bus operations and travel time reliability

The major parameters considered in the literature on the effects of highway infrastructures on public bus operations and travel time include Total Bus-Stop Time (TBST), Bus Dwell Time (BDT), Boarding Time (BT), Alighting Time (AT), Travel Time (TT) along the road segment, Total Travel Time (TTT), Free Flow Speed (FFS), Signalized Intersection Delay (SID), Bus Stop Location Impact (BSLI), Travel Payment Method (TPM) and others. (Dueker et al., 2004; Martin, Abdul-Aziz, Annin & Oduro, 2013; Preethi & Ashalatha, 2016; Yashaswi & Srinivas, 2016) These measures were geared towards finding a reliable travel time determination tool. Other research works on effects of road transport infrastructure on public bus operations and travel time reliability include Oni and Nwoye (2016); Olaogbebikan, Ikpechukwu, Akinsulire and Okoko, 2013; Furth and Rahbee, 2000; Saka, 2001; Rajbhandari et al., 2003; Dueker et al., 2004; Jaiswal, Bunker, and Ferreira, 2010; Mushule, 2012; Meng and Qu, 2013; and Gupta, 2014. These studies do not quantify the real percentage contribution of fixed and operational facilities to travel time uncertainties in metropolitan Lagos.

3. Methodology

3.1. Research design

This research adopted a cross-sectional research design which is a combination of quantitative, field experiments or case study and survey research methods. The pilot study was undertaken for three days (Monday, Friday, and Saturday based on popular pronunciation of bad experiences by commuters) to measure the peak and off-peak travel time, permissible free-flow speed, and to identify bus stops with substantial traffic activities (congested nodes). Also, to develop the best method for in-vehicle travel time data captures.

3.2. Sources of data and research instruments

Two types of data sources were used for this research. They are primary (direct traffic observation, travel time measurement, and questionnaire administration) and secondary data sources (printed information from Transport Ministry and other literature).

The following instruments were used for data collection from the three highways of study:

- (1) GPS-global positioning system for measuring coordinates of bus stops and bus speed;
- (2) Traffic count sheet & observation sheet;

- (3) Stop Watch for in-vehicle travel time distribution measurement across road segments;
- (4) Structured Questionnaires for gathering travel time information from bus operators.

The questionnaire used for this research contains two different sections that are relevant to this research. Section A contains the socio-economic and demographic characteristics of respondents. It was designed to collect information about operators' social profiles. While Section B contains questions on bus operators' challenges and cost effects on vehicle maintenance, fuelling, and profit margin.

3.3. Study population, sample size and sampling techniques

From the outcome of the field study, a total of 530 buses were counted at the motor parks along the study area. However, a sample size of 240 bus operators were selected using the formulas provided by Taro Yamane $\{n = N/1+N(e)^2\}$ and Cochran $\{n = Z^2 \times pq / e^2 \text{ divided by } 1 + (Z^2 \times pq / e^2 N)\}$ for questionnaire administration.

Table 2: Buses survey and sample size selection

BUS POPULATION SURVEY (per hour)			
S/N	Location	Bus Population	Sample Taken
A	Oshodi-Abeokuta Road		
1	Sango	36	15
2	Toll-Gate	22	15
3	Oshodi	152	60
	Total	210	90
B	Ikorodu-Jibowu Road		
1	Ikorodu R/About	90	40
2	Sabo/ Ikorodu	31	10
3	Jibowu/Yaba	81	40
	Total	202	90
C	Lekki-Ajah Road		
1	Marina	32	15
2	Leventis	21	15
3	Ajah	65	30
	Total	118	60
	Grand total	530 buses	240 samples

Source: Authors Fieldwork (2020).

This study utilized the combination of a cluster, stratified, and convenient random sampling techniques to collect data on bus travel time and delays distribution during the morning and evening peak periods (6:00 a.m. to 10:00 a.m.) and (4:00 p.m. to 7:00 p.m.) on both directions from Monday to Saturday. A combination of clustered and convenience sampling techniques were used to select bus operators for questionnaire administration at the bus parks.

3.4. Techniques of data analysis

Data collected through field measurement were analyzed as follows:

The effects of prolonged running time on bus operators' profit margin were analyzed using statistical computation of time series and cost changes with bus travel time elongation. The frequency of bus travel was used to determine the number of trips possible as well as the number of trips lost along each of the three highways studied.

The multiple correlation model was applied to test the degree and significance of the relationship between the extent of bus travel delay, additional fuel consumed, and the number of trip losses in the study area. The outcome of this significant test was used to confirm or reject the research hypothesis H_{01} . Finally, the results were presented using frequency tables, graphs, and charts.

4. Results and discussions

4.1. Public bus drivers' responses to effects of travel delay on operators' profit margin

This chapter discusses the perceptions of public bus drivers on the effects of public bus travel delays on their operations (trip loss and maintenance cost) and monthly returns. The results show that 97.5% (234) of the respondents are male while 2.5% (6) are female, meaning that the business of public bus driving is dominated by the male gender. That is, public bus operational activities are almost completely being handled by men in Lagos metropolis at present. This may be connected with the way the bus Union and its operational activities are organized in a violent and non-friendly manner to the opposite gender.

Further, the majority of the public bus drivers (117: 48.8%) are in the age group 31-40years and followed by another large group of drivers in the age range of 41-50years (93:38.8%). Young drivers within the age group of 18-30years make up the least group of 3.8% (9) while drivers in the group 51-60years constitute 8.8% (21).

Also, the educational background of drivers as reported by the respondents show that majority (96: 40%) possesses vocational education (meaning that they learnt certain skills before becoming a driver but did not use it as their source of income). Drivers with primary and secondary education are 60 (25%) while those one with tertiary education make up 18.8% (45). The groups of drivers who are without any formal education constitute 16.3(39).

The implication of this education status is that the poor attitude of drivers towards obeying traffic rules and safety regulations in Lagos metropolis may be as a result of the low level of drivers education in the state (only 18.8% attended tertiary institutions where logic and philosophy that mold characters were being taught).

More so, the most frequent travel destination of bus drivers within the study area is shown in Table 3.

Table 3: Distribution of bus operators' most frequent destinations within the study area

Frequent travel destination for bus operators												No. of destination outside the zone	Potential traffic from outside the zone
Locatin	Apapa	Ikorodu	Iyana Ipaja	Oshodi	Mile12-Ketu	Shomolu	Yaba	Lagos Island	Lekki-Ajah	Victoria Island	Total		
Oshodi-Abeokuta expressway	9(10%)	0	15(16.7%)	63(70%)	0	3(3.3%)	0	0	0	0	90 (100%)	2 (but make up 13.5% of buses sampled on the corridor)	Medium
Ikorodu expressway	6(6.7%)	12(13.4%)	0	4(4.4%)	16(17.8%)	0	20(22.2%)	24(26.4%)	1(1.1%)	7(7.7%)	90 (100%)	5 (but make up 47% of buses sampled on the corridor)	High
Lekki-Ajah expressway	2(3.3%)	0	0	1(1.7%)	0	0	0	6(10%)	33(55%)	18(30%)	60 (100%)	2 (but make up 5% of buses sampled on the corridor)	Low

Source: Author's fieldwork, 2020.

The results of the number of trips made daily by public bus operators in the study area is shown in Table 4. The table shows that Lekki-Ajah road performs better than Ikorodu road, while Ikorodu road performs better than Oshodi- Abeokuta expressway in terms of traffic flow.

Table 4: Distribution of daily bus trips across the three highways of study

Location	Number of Trips made Per Day					Total
	3 trips	4 trips	5 trips	6 trips	7 trips and above	
Oshodi-Abeokuta expressway	30(33.3%)	43 (47.3%)	13 (14.3%)	4 (4.4%)	0	90(100%)
Ikorodu expressway	6 (6.6%)	36(40%)	36(40%)	6(6.6%)	6(6.6%)	90(100%)
Lekki-Ajah expressway	0	0	0	21(35%)	39 (65%)	60(100%)

Source: Author's fieldwork, 2020

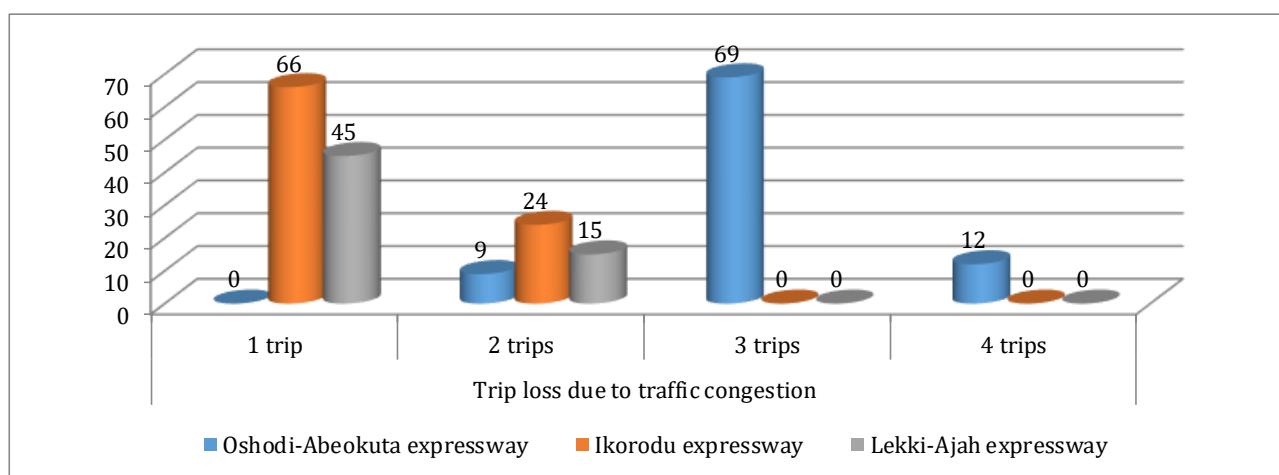
To corroborate the reported number of trips made per day, the bus operators' travel time across the study area was evaluated (Table 5). The result shows that Oshodi-Abeokuta road was reported with the worst travel time (2hrs to 4hrs).

Table 5: Reported travel time of buses along the studied highways in Lagos Metropolis

Location	Travel time of buses along the studied highways				Total
	30min.-1hr	1hr-2hrs	2hrs-3hrs	3hrs-4hrs	
oshodi-abeokuta expressway	0	9(10%)	60(66.7%)	21(23.3%)	90(100%)
ikorodu expressway	12(12.3%)	78(87.7%)	0	0	90(100%)
lekki-Ajah expressway	36(60%)	24(40%)	0	0	60(100%)
	48	111	60	21	240

Source: Author's fieldwork, 2020.

Further probe of bus drivers' daily trip loss due to traffic congestion (Figure 3) revealed that operators along Oshodi-Abeokuta road reported the highest number of trip losses. The implication is that operators on this road will most time not meet up their daily delivery of bus returns to bus owners. Therefore, they often hike the transport fare to between 100% and 300% (as observed during the in-vehicle travel time measurement) depending on the severity of the delay observed or informed.

Figure 3: Distribution of Daily Trips loss by Bus Operators across the Three Highways of Study

Source: Author's fieldwork, 2020.

It was also learned from the bus drivers that longer travel delays usually make their buses overwork resulting in bus breakdown and an increase in monthly maintenance costs. The operators along Oshodi-Abeokuta Road reported spending up to 50% of their monthly income on maintaining the buses for regular operations. This is an indication that operators along Ikorodu and Lekki-Ajah roads will make more monthly profit than those operating along Oshodi-Abeokuta Road.

More importantly, the cost of bus fuelling per day across the study area (Table 6) revealed two categories of fuel costs. That is, operators spending N5,000 - N10,000 and those spending 10,000-

N15,000 daily for fueling. Most of the operators who spent N10,000 - N15,000 daily on fuel are those using 24, 32, or 60-seater buses with diesel engines for passenger services.

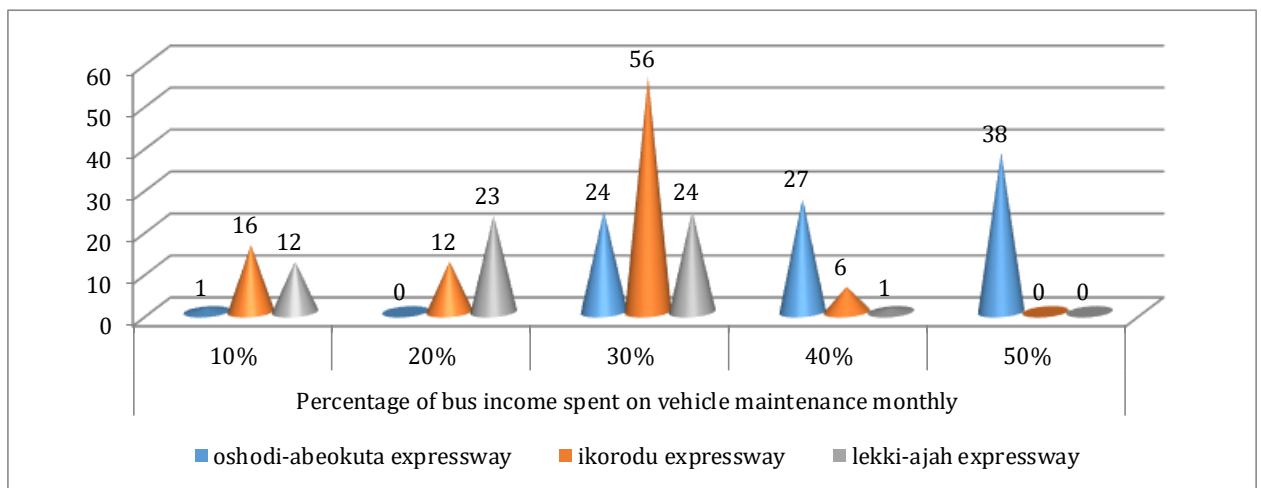
Table 6: Daily bus fueling cost an extra cost of bus fuelling due to congestion

	The daily cost of vehicle fuelling			The extra cost of fuelling due to daily congestion			Amount loss due to congestion by selected operators in the study area		Amount loss by yellow bus operators (excluding BRT & LBSL) in Lagos metropolis (145,000 vehicles)
	N5,000- N10,000 (14 & 18 Seater buses)	N10,000- N15,000 (24, 32 & 60 Seater buses)	Grand Total	N1,000- N5,000 (14 & 18 Seater buses)	N5,000- N7,000 (24, 32 & 60 Seater buses)	Total	Monthly loss	Yearly loss	
Oshodi-Abeokuta expressway	51(56.7%)	39 (43.3%)	90 (100%)	66 (73.3%)	24 (26.7%)	90 (100%)	N14.94M	N 179.28M	
Ikorodu expressway	78 (86.7%)	12(13.3%)	90 (100%)	90 (100%)	0	90 (100%)	N13.50M	N 162.0M	Monthly: N 21.924billion
Lekki-Ajah expressway	60 (100%)	0	60 (100%)	60 (100%)	0	60 (100%)	N9.0M	N 108.0M	Annually: N 112.361billion
Total	189	51	240	216	24	240	N 37.44M	N 449.28M	

Source: Author's fieldwork, 2020.

Also, the result from the analysis of the extra cost borne by bus operators daily as shown in table 4.4 revealed that operators along Oshodi-Abeokuta road spend a higher amount on extra fuelling than those on the other two highways. The implication of this is that operators along Oshodi-Abeokuta road will still record lower monthly bus income than others.

Figure 4: Percentage of Bus Income Spent Monthly on Maintenance by Operators in the study area



Source: Author's fieldwork, 2020.

Furthermore, a probe into the percentage of bus income spent on maintenance revealed that bus operators spent between 10% and 50% of their monthly income maintaining their buses. Operators along Oshodi-Abeokuta road spent the highest amount (50%) meaning that they lost more of their monthly income to vehicle maintenance. Therefore, they often hike the transport fare to between 100% and 300% (as observed during the in-vehicle travel time measurement) depending on the severity of traffic delay observed or information received from other operators working ahead of them.

It was also discovered from the bus drivers that severe congestion usually makes their buses to overwork resulting to bus breakdown and an increase in monthly maintenance cost. Importantly, the bus operators within the study area use the 14, 18, 24 & 32 seater buses for travel services across the

sixteen (16) to seventeen (17) major bus stop segments of the study area. More importantly, they all utilize the used imported buses (Tokunbo vehicles of more than 10 years of age) for their services which mean the buses used across the three studied highways are relatively in same old condition.

Nonetheless, the nature of the problem encountered by bus operators shows that loss of bus trips (35.4%), constant vehicle breakdown (11.7%), and loss of daily revenue (52.9%) are the reported challenges to their business success. Therefore, it can be concluded that travel delays have proportionally impacted bus operators' monthly profit margin due to an increase in daily operational costs in the Lagos metropolis.

The recommendations given for effective solution are eight (8) out of which 4 are more important to the bus operators. These include road expansion; provision of extended bus stop lay-bys, BRT corridor expansion, and traffic agents commitment and patriotism. Therefore, it can be concluded that travel delays impact public bus operators' profit margin through the loss of up to four (4) trips, increased maintenance frequency, and loss of up to fifty (50) percent of monthly returns on bus repairs.

4.2. Hypotheses testing

To further confirm the significance of the relationship between uncertain bus travel time and the operators' monthly profit margin in metropolitan Lagos, data on bus travel time and extra cost of fuelling due to congestion were used as variables while the Correlation technique was used to determine the level of significance.

The result of the test shows that prolonged travel delay has significant correlation with:

- i. operators' extra cost of fuelling (r-value of 0.528, sig. @ 0.01 & 0.05 levels);
- ii. percentage of income spent on maintenance (r-value of 0.645, sig. @ 0.01 & 0.05 levels);
- iii. number of trip loss daily (r-value of 0.239, sig. @ 0.05 level)

Therefore, the hypothesis (H_{01}) that there is no significant correlation between travel time uncertainty and yellow bus operators' monthly profit margin in metropolitan Lagos is rejected. This means that there is a positive significant correlation between prolonged bus travel time, number of trip losses, and percentage of income spent on maintenance due to the congestion effect. This result empirically confirmed that prolonged bus travel delay significantly reduces bus operators' monthly profit margin. Because it reduces their income and make them to always hike their bus fare to be able to make daily returns (at the detriment of commuting passengers).

5. Conclusion

This study has examined the effects of yellow bus travel delays on public bus monthly profit and daily returns found that the major factors affecting the length of travel delays within the metropolitan Lagos are: low highway network and bus stop lay-by capacity (as found along the three highways); proliferation of traffic signals (as found along Lekki-Ajah road); poor highway nodal connectivity (common to the three highways); and lack of enforcement and improper road intersection control (common to the three highways). These factors impact daily on public bus trips resulting in prolonged bus travel time and unreliable arrival at destinations. The effects of this unplanned delay are majorly reduction in operators' monthly profit margin, loss of up to four (4) trips daily, increased maintenance frequency, and loss of up to fifty (50) percent of monthly returns on bus maintenance or repairs.

This study, therefore, concludes that congestion has a negative economic effect on yellow public bus operators' monthly income in metropolitan Lagos.

6. Recommendations

Based on the study findings and conclusion, the following recommendations are proffered:

- The Ministry of Transport and the National Union of Road Transport Workers (NURTW) should collaborate to adopt a fare/cost regime that will prohibit incessant hikes in transport fares to reduce the economic burden of traveling by public buses in Lagos metropolis.
- Strict enforcement of traffic laws prohibiting bus stop obstructions by public bus drivers should be uncompromisingly enforced in metropolitan Lagos.

- A heavy fine should be imposed on public bus drivers who obstruct traffic during daily operations to discourage others from causing congestion on Lagos roads.
- The Public-Private Partnership model should be developed with bus operators' unions (a major stakeholder) to replace existing bus stops/lay-bys with multi-story and extended laybys which will allow for off-road parking along major bus stops on Lagos highways.
- LASTMA, FRSC, VIO, and other traffic management agencies should be encouraged to periodically organize road traffic education and off-road parking training for the commercial bus operators in metropolitan Lagos to prevent road traffic obstruction.
- On-road parking and use of roundabouts and intersections (such as Ikorodu, Sango toll-gate, Oshodi, Ajah, and others) for bus stations and passengers loading must be eradicated in metropolitan Lagos to eliminate traffic gridlock and reduce travel delays.
- The proliferation of traffic signals along the Lekki-Ajah highway must be reconsidered for an alternative overhead bridge to improve traffic flow and on-time arrival at the destination.
- Agencies of Government should provide a good and reliable bus shelter at each bus-stop where there is no shelter and maintain the other ones that have existing bus shelters to reduce passengers' waiting for stress and crowding on road.

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Conflicts of interest/Competing interests

Not applicable

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