



An Examination of the Relationship between Traffic Congestion and Vehicle Operating Cost in Lagos State

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study investigates the association between traffic congestion and vehicle operating costs for freight operators in Lagos State Nigeria. It showcases the importance of transport for economic activities and the role of road freight transport in improving logistics efficiency. The research is focused on the traffic congestion adverse effect on freight transportation operational costs including fuel consumption and maintenance cost. The growing population as well as vehicle numbers in cities lead to traffic jams that cause costs to increase for the freight transport sector. Existing studies have addressed congestion-related costs from a variety of perspectives, identifying considerable financial impairments for businesses. Nevertheless, there is no research to document the effect that congestion has on operating expenses for motor vehicles. The research used a purposive sampling technique to select 353 respondents from registered haulage companies in Lagos State. Survey and interview methods were used in the study while data was analyzed using Pearson's Product-Moment Correlation Coefficient, showing a notable and negative relationship between vehicle operating costs and traffic congestion. The findings demonstrate the costs

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incurred through efficiency losses and heightened expenses by freight operators due to traffic congestion. The study gives recommendations that policymakers and stakeholders need to be strategic in countering congestion and reducing the operational burden on freight operators, which can be useful data in research on transport challenges in urban areas with the view of improving sustainable transport system planning.

Keywords: Traffic congestion; vehicle operating costs; freight operators; road freight transport; fuel consumption; maintenance costs.

1. INTRODUCTION

Transportation is one of the significant components of the modern world which is planned to ensure effective and cheap movement among other society's parts to give every citizen maximum mobility [1]. It is vital to all activities in economic operations, such as the transportation of raw materials, workers, inputs, and outputs along the supply chain, consumers to services, and goods to customers [2]. In comparison, road freight transportation refers to the delivery of goods to their final destinations through the roads. It increases the logistic proficiency so that goods reach where they are demanded by the customers promptly [3]. The use of the road for freight transportation opens the gate for distributing goods to customers. It builds time and location utility. The delivery of the product is when and where it is required. Since freight transport is perceived as a low-cost element of production, trucks are usually used for purposes that may not be ideal in terms of freight efficiency but may be optimal when the logistical chain (including production and warehousing techniques) is considered [4].

According to Engström, [4] roads can constitute a barrier, because road freight transport is a source of congestion. Due to the increase in population in the urban cities, the cars on the road have increased, thereby causing congestion. Thus, as the number of vehicles on the road increases at a particular time, road traffic congestion occurs. However, road traffic congestion has caused so many problems for transport-related companies including the road freight industry because of their inability to meet the demand of customers through their supply chain due to delays arising from traffic congestion. Congestion reduces productivity and raises the overall cost of transport services for the freight transportation industry. More so, increased costs could arise as a result of higher fleet operating costs, lower fleet and vehicle utilization, lower fuel efficiency, higher emissions from idling, and a reduction in drivers'

productivity hours [5]. In Nigeria for instant, the issues of cost-related to congestion and other effects cannot be over-emphasized, most especially in metropolitan city like Lagos State. Lagos State has some salient points that make it be a very pivotal case study in urban transportation research. This is derived from its complex and densely urbanization with its economic role within the continent of Africa [6]. Lagos offers a cocktail of both conventional and unconventional transport networks, and, therefore, it serves as the perfect place from which to derive at challenges facing urban mobility, such as road congestion.

However, congestion-related costs of transport operations have been investigated by many researchers. Shirley and Winston [7] look at how much highway congestion costs businesses in terms of inventory. According to the study, the highway cost of congestion on inventory and logistics is estimated to be US\$7 billion. Also, Shoaeb, El-Badawy, and Gabr [8] examined the direct cost of urban traffic congestion in the main corridors in Mansoura City, Egypt. It was found that fuel consumption, travel time, actual congested travel time, and non-recurring travel delays due to crashes and road restrictions are all factors to consider. Consequently, they estimated the annual direct traffic congestion cost to be 150.37 million Egyptian Pounds (EGP). In congestion-related costs, RACQ [9] estimated the average repair cost for different vehicles that traveled 15,000 kilometers per year was 8.8 cents per mile in 2015. American Automobile Association, [10] looked at the average cost of owning and operating a car throughout a five-year personal use period and a 75,000-mile ownership period. Based on 2013 prices, the average maintenance cost included oil cost of 5.1 cents per mile. Litman [11] found that the cost of vehicle maintenance for urban peak travel in Melbourne, Australia was 15% higher than for urban off-peak travel.

According to Shoaeb, et. al., [8], vehicle operating cost (VOC) is the excess fuel

consumption cost and additional maintenance costs due to congestion. The total excess gasoline and diesel consumption due to traffic congestion, as well as excess fuel subsidy costs, were estimated to be around 2.85 billion EGP annually by the World Bank [12] in Cairo. According to another study by Khan and Islam, [13], the total annual cost of burned fuel in Dhaka city due to congestion was 178.6 million USD. Nevertheless, traffic congestion-related operating costs are eminent and colossal. However, there is content that the understanding of the causes of traffic congestion remains quite unsettled and differs. Thus, this needs further examination.

Furthermore, the body of scholarly literature investigates traffic congestion in connection to freight transportation and logistics from several angles. Litman [11] discusses new and improved methods for resolving traffic congestion issues in cities. It emphasizes win-win strategies that aid in the achievement of multiple planning goals and thus maximize the overall benefits of freight transportation. This marks a new planning framework that broadens the range of impacts and options are taken into account during the planning process. McKinnon [14-15] examined the impact of congestion on logistical efficiency in developed countries. Zhang, and Nie, [16] examine the impact of congestion on freight transportation efficiency in terms of the perceived impact of policies to reduce congestion. In New Zealand, Sankaran, Gore, and Coldwell [17] examine traffic congestion concerning freight transportation and logistics in the context of Auckland economies using manufacturers and distributors and their supply chains. In Nigeria, Fadare and Ayantoyinbo [5] assessed the extent to which traffic congestion causes each of the identified variables to manifest sampled shippers, truck drivers, and supplies to establish the relationship between decrement in fuel efficiency, shrink in market coverage, higher cost of fleet operation, higher cost of shipment, and drivers' stress; they also determined the extent to which traffic congestion causes each of the variables to manifest shippers, truck drivers, and supplies to find the relationship between decrement in fuel efficiency, shrink in market coverage, higher cost of fleet operation, higher cost of shipment. This is problem instigates the choice of Lagos State, the commercial centre of Nigeria, as a study area on congestion and vehicle operating costs, with its characteristics of being urban dynamics unique to present various unique challenges in transportation. According to Falayi [18], Lagos is one of the highly populous cities in Africa and it is

characterized by high economic activities and complex network transportation systems. A study carried out by Adeleke and Afolabi (2020) has realized that vehicular operating costs connected to traffic congestion in Lagos include increased fuel consumption, raised maintenance costs, and vehicle depreciation over long periods. Dano, et al., [19], further points to the strategic location of Lagos in associating urban planning with both congestion and transportation economics. The congestion of Lagos provides, therefore, not only the practical setting for an analysis of the direct costs of operation borne by the vehicle owner or driver but also an overview of the wider socio-economic implications of urban transport challenges.

More importantly, previous studies on the effect of road traffic congestion on vehicle operation costs such as fuel consumption and maintenance cost have received little attention over time. Therefore, this study examined the effect of road traffic congestion on vehicle fuel consumption cost, and vehicle maintenance cost in Lagos State.

2. LITERATURE REVIEW

This aspect analysed the concept of road traffic congestion and vehicle operating cost which are as follows:

2.1 Road Traffic Congestion

There is no globally agreed upon definition of traffic congestion as it is both a physical and relative matter [20]. Transportation experts use the term 'traffic congestion' to describe the physical phenomenon that occurs when demand exceeds the capacity of road space, leading to reduced speeds, longer travel times, and longer motor vehicle queues [21]. This occurs when the level of performance on the road does not meet the expectations of road users [22]. The issue of congestion can simply be attributed to the lack of transport infrastructure such as road space, parking areas, road signals and good traffic management [23]. Therefore, urban road congestion arises due to excessive usage of road infrastructure over limits, and it has lower speeds, longer commuting time, and longer queuing of vehicles. Busy and thriving cities economically, most times, will never be free of traffic congestion [24]. There are two different opposing views on the traffic congestion [22]. On the other hand, some people believe that it is a signal of economic development and

urbanization. The second one is called the idea of the downfall of urban living.

2.2 Types of Traffic Congestion

Brownfield et. al., [25] defined three forms of congestion: repeated congestion, non-recurring congestion, and the pre-congestion condition. These classifications are made based on traffic congestion frequency and predictability which are two factors that influence driving behavior. Congestion expense is expected to depend on the type of congestion. Measuring recurring congestion costs is potentially more problematic due to information scarcity. Certain routes are likely to experience non-recurring congestion, which is similar to accident hotspots. In these instances, the drivers may 'learn' to predict the expected cost of a likely delay and accurate alternative routes. Pre-congestion will entail a price tag that is equal to the one paid for congestion, such as the loss of environmental control, environmental degradation, and other consequences. For road freight transport companies, the fact that congestion has only become a time-consuming inconvenience is more than that. The fact that the bottleneck of traffic congestion has reduced the number of trips a truck driver can do in a day, makes transportation expensive.

According to Brownfield et. al., [25] congestion can be divided into the following segments:

- **Recurrent Congestion:** This occurs over and over in a specific spot. Regular road users who use the route at specific times could be expecting it. Morning or evening rush-hour congestion, or congestion caused by a weekly occurrence like a street fair, are instances of recurring congestion.
- **Non-recurrent Congestion:** This happens at a place and this happens at unspecified intervals. It is unexpected and unpredictable by the driver and often occurs due to sudden happenings like accidents, car breakdowns, or other road capacity losses.
- **Pre-congestion (borderline):** This takes place when the force conditions have been violated but the state of complete congestion has not been achieved. This could take place on either side of the inflammation after the period when the congestion developed, or it could take

place upstream or downstream of the congestion that was already happening.

2.3 Causes of Traffic Congestion

Several specific circumstances cause or aggravate congestion: rapid urban population growth, economic growth, increased employment opportunities, increase in the number of cars and people using cars, low capacity of transportation infrastructure, road layout, underinvestment in road infrastructure, poor traffic management, shortage of street parking, signal and equipment [26-28] Mensah, Annan, & Andoh-Baidoo, 2014.

In developing nations, congestion is caused due to the following factors: unplanned cities, inadequate discipline, alternate traffic ways, improper management, and inefficient lane management [29]

- **Unplanned cities:** Roads are narrow and badly constructed. As cities expand haphazardly, no plans are made to scale road capacities, resulting in multiple bottleneck highways that stay crowded for lengthy periods. Furthermore, many emerging nations have seen an explosion in their motor population, failing traditional traffic control measures.
- **Inadequate discipline:** Drivers are frequently inadequately trained to observe lane discipline. Poor lane discipline, particularly at traffic intersections, exacerbates an already congested situation. Furthermore, cars regularly disregard red signals and block intersections, adding to traffic congestion. These issues are worsened by inadequate traffic law enforcement, which provides little incentive for drivers to observe the regulations.
- **Alternate traffic means:** countries with fast-growing economies have witnessed a surge in the number of vehicles across major cities. These cities seldom have efficient mass transit systems, forcing people to operate private vehicles. This problem is compounded by the social stigma, where people view operating a private vehicle as a sign of prosperity, while public transport is viewed as being used by the lower echelons of society.
- **Archaic management:** traffic junctions are often unmanned, thereby allowing drivers

to drive chaotically. Even if a traffic junction is regulated by police or a traffic light, traffic junctions are essentially independent of any traffic management plan, just optimizing the specific junction traffic flow in the direction of maximal traffic build-up. Furthermore, these approaches enhance traffic mismanagement in already congested roads, accelerating congestion collapse.

- **Improper lane management:** Lane management is an important factor in managing traffic. Many types of vehicles try to overtake other vehicles even in the single undivided road. This is the primary reason that city roads lack lane dividers, which separate the lanes into incoming and departing traffic.

2.4 Congestion and Freight Movement

The congestion is counterproductive, and as a result, the freight industry and the trucking businesses pay higher costs overall [5].

Congestion will lead to fleet operations costs, lower fleet and vehicle utilization, lower fuel efficiency, greater emissions due to idling, and fewer hours of "productive" service for drivers which implies greater expenditures. However, these delivery delays and longer trip times create disruptions that downplay the reliability of the suppliers at every link of the supply chain, resulting in business implications that add up cost at every link in the supply chain [5]. If transportation is efficient, manufacturing and retail firms can decrease inventory levels due to them being assured the goods arrive on time and where needed. Last but not least, they can diversify their sourcing channels. On the other hand, the other side of the coin is also true. A firm may have more inventory in case the transportation system is congested and therefore unreliable to keep the production going and the availability of goods steady. Shortage of stock and disruption of production plants create a negative impact on the businesses which were re-engineered based on a lean-inventory just-in-time model.

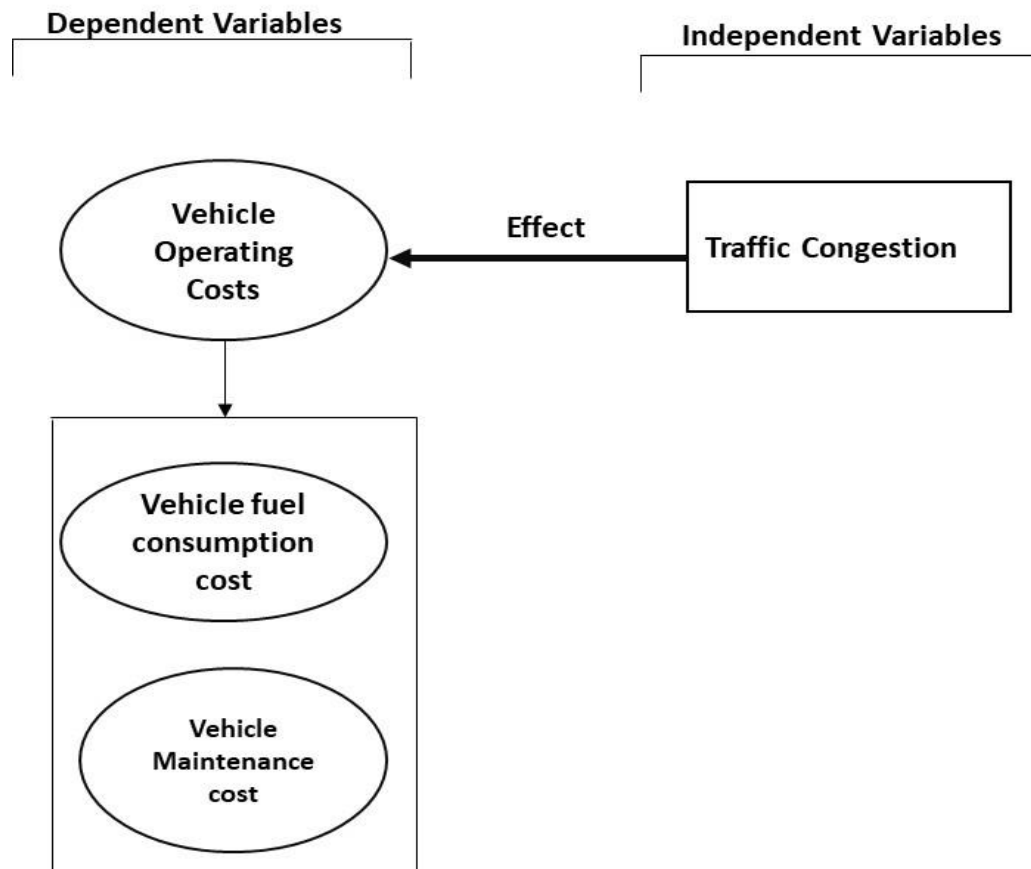


Fig. 1. Conceptual framework
Source: Author compilation (2024)

Inventory is a cost for a business. In addition to the money of a firm that is tied up in inventory, preventing it from more productive activities, inventory must be kept and insured, the money invested is in danger if it expires. This just-in-time inventory management to balance transportation uncertainties has a crucial economic effect on the business and also customer service. Transportation has never ceased to be the most important component in business effective exploitation of their economic and competitive features. There will be no just movement of goods and services but more of the swift, fast, and reliable one that will create and sustain economic activity. No longer is travel a choice; it has become an obligation [30].

2.5 Conceptual Framework

From prevailing scholarly literature on road traffic congestion and freight transportation in developed and developing countries, the majority of the relevant literature stipulated that the major impact of congestion on freight movement is much of both direct and indirect cost implications for the haulage company. Therefore, this study focused on the vehicle operating costs (i.e. vehicle fuel consumption cost and vehicle maintenance cost) as the dependent variable and Traffic congestion (measured as an increase in travel time) as the independent variable. The effect between these two variables was examined in the study as illustrated in Fig. 1.

3. METHODOLOGY

This research was conducted in Lagos State, South-west Nigeria. The freight transport in Lagos State is an integral aspect of the economy and social life. Industries need some goods shipments to keep the business and it varies from large shipments of bulk commodities to packages within and outside Lagos State [31]. The study concentrates on road freight transport operators in the study area. In other words, there are forty-one (41) registered haulage companies in Lagos State. The total staff of this companies is 3026 staff which forms the population of the study. The sample size was determined by using Slovin's formula. The formula is expressed as follows:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where: N = Population

e = Desired margin of error (percentage allowance for non-precision because of the use of the sample instead of the population).

n = The sample size.

$$n = \frac{3026}{1+3026(0.05)^2} = 353 \quad (2)$$

A purposive sampling strategy was employed to select the sample size of 353 respondents (Staff) from haulage companies in the study area which includes TSL; Noask; GPC; Ekili; GMT; Starlink and GHRL. The management and drivers of the companies were asked to fill in the questionnaires. Surveys and personal interviews were the main data sources for the research. Adhering to the study objectives, the questionnaire was structured and then administered to the selected respondents in 14 14-day period due to location differences of the selected companies. Data was analyzed using PPMC (Pearson Product Moment Correlation Coefficient) to achieve the study's aim. This approach is convenient for its simplicity and accuracy in determining the linear relationship between two continuous variables, which is also applicable in various research fields since it is easy to interpret and apply [32]. Rather than other non-parametric techniques, PPMC's standardized range and the direct measurement of correlation strength provides the researcher with a concise way to present findings and makes comparative analysis easier [33].

4. RESULTS AND DISCUSSION

To the objective of the study which is to analyze the relationship between traffic congestion and vehicle operating cost, Pearson Product Moment Correlation Coefficient (PPMC) analysis was employed and the result is in Table 1. however, vehicle operating cost was measured with vehicle fuel consumption and vehicle maintenance cost. Furthermore, the result revealed that there is a negative and significant (at 0.001 level of significance) relationship between Traffic Congestion and vehicle fuel consumption cost with an r-value equal to -.291, which means that whenever there is a positive change in traffic congestion there was a negative change in vehicle fuel consumption cost and vice versa. Also, there is a negative and significant (at 0.001 level of significance) relationship between Traffic Congestion and vehicle maintenance cost with an r-value equal to -.188, which means that whenever there is a positive change in traffic

Table 1. Correlations between traffic congestion and vehicle operating cost

		Traffic Congestion	Fuel Consumption cost	Vehicle maintenance cost
Traffic Congestion	Pearson Correlation	1	-.291**	-.188**
	Sig. (2-tailed)		.000	.001
	N	310	310	310
Fuel Consumption cost	Pearson Correlation	-.291**	1	.104
	Sig. (2-tailed)	.000		.069
	N	310	310	310
Vehicle maintenance cost	Pearson Correlation	-.188**	.104	1
	Sig. (2-tailed)	.001	.069	
	N	310	310	310

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

congestion there is a negative change in vehicle maintenance cost. Consequently, it can be deduced that there is a negative and significant relationship between traffic congestion and vehicle operating costs among the selected freight operators in Lagos State.

5. CONCLUSION AND RECOMMENDATIONS

The results of this study, therefore generated robust evidence for the negative and significant relationship between traffic congestion and the operational costs of freight operators within Lagos State. These connections highlight that freight operators face the wastes of efficiency and increased expenses due to recurrent and ubiquitous issues of traffic congestion. It therefore supports the research of Sun, and Lu, [34] that fuel consumption, maintenance cost, and delays that are largely characteristic of traffic congestion in urban areas put a toll on the running costs for freight transportation. As well, researches done by Shafiei, et al., [35] prove that the direct impact of road congestion on the economic performance of freight operations is substantial, leading to an increase in the cost structure due to overall vehicle idling time and associated gas wastage. These operational challenges combined with traffic congestion are not just essential causes but also the ones behind other serious reasons such as customers' dissatisfaction and potential loss of business opportunities, as described by Abuh and John, [36]. Moreover, Adepoju, Balogun, and Bekesuomowei, [37-38], in their study, highlight the role of congestion in the wear and tear of vehicles, as it results in more frequent repairs and renewals, in turn, leading to higher freight operation costs.

In this context, it becomes critical for the lawmakers and stakeholders to analyze possible solutions meant to solve the problems causing traffic jams in Lagos State. Providing efficient traffic management systems, increasing the capacity and quality of the road system, and promoting the application of alternative transportation modes are some strategic solutions that are expected to solve the aforementioned issues, consequently, reducing the operational pressure from freight operators. This study not only provides empirical evidence on the persistent costs of traffic congestion on fleet operations in the region but also recommends a holistic approach to address the problem in terms of policy formulation to plan for sustainable transport systems.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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