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Traffic Congestion in F.C.T: Demand and Supply Approach

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Abstract

This study examined traffic congestion in Abuja metropolis, F.C.T.- Nigeria using demand and supply approach. The study adopted survey research design. Primary data was collected using questionnaires. Descriptive statistics was used to analysed the data with the aid of tables and graphs. It was discovered that as a road reaches its capacity, each additional vehicle imposes more total delay on others than they bear, resulting in excessive traffic volumes. Congestion is mainly due to the intensive use of automobiles, whose ownership has spread massively in the F.C.T. in recent decades. The study revealed that traffic congestion causes serious consequences in the F.C.T. by increasing travel time, arrival unreliability particularly, during peak hours, fuel consumption, pollution emissions and driver stress, and reduce life satisfaction. The study recommends the need to expand road capacity and greater utilization of modes of transportation with a high occupancy coefficient, including carpooling and rationalization of on-street parking.

Key words: *Traffic Congestion, Demand, Supply.*
JEL: R4, R40 and R41

1. Introduction

Traffic congestion refers to the way the movement of vehicles is delayed by one another because of limited road capacity (Rahane & Saharkar, 2014). In simpler terms, as cited in Vencataya et al. (2018), road congestion occurs when the demand for traffic nears or surpasses the capacity of the road network (Raheem et al., 2015). Each transport mode shares the common goal of fulfilling a derived transport demand, and each transport mode thus fills the purpose of supporting mobility.

Transportation is a service that must be utilized immediately since unlike the resources it often carries, the transport service itself cannot be stored. Mobility must occur over transport infrastructure having a fixed capacity, providing a transport supply. In several instances, transport demand is answered in the simplest means possible, notably by walking over a landscape that has received little or no modifications. However, in some cases elaborate and expensive infrastructure and modes are required to provide mobility, such as for air transportation.

Transportation is a market composed of suppliers of transport services and users of these services. Well-functioning transport markets should allow transport supply to meet transport demand so that transport needs for mobility are satisfied.

An economic system including numerous activities located in different areas generates mobility that must be supported by the transport system. Without mobility infrastructures would be useless and without infrastructures mobility could not occur or would not occur in a cost-efficient manner. This interdependency can be considered according to two concepts, which are transport supply and demand. Transport supply and demand have a reciprocal but asymmetric relation.

While a realized transport demand cannot take place without a corresponding level of transport supply, a transport supply can exist without a corresponding transport demand. This is common in infrastructure projects that are designed with a capacity fulfilling an expected demand level, which may or may not materialize, or may take several years to do so. Scheduled transport services, such a public transit or airlines, are offering a transport supply that runs even if the demand is insufficient.

Infrastructures also tend to be designed at a capacity level higher than the expected base scenario in case that demand turns out to be is higher than anticipated. In other cases, the demand does not materialize, often due to improper planning or unexpected socioeconomic changes.

Transport demand that is met by a supply of transport services generates traffic (trucks, trains, ships, airplanes, buses, bicycles, etc.) on the corresponding transport infrastructure networks. The traffic capacity is generally larger than the actual transport demand since the average utilization level of vehicles rarely reaches 100 percent.

For instance, empty hauls of trucks, an underutilized container ship capacity sailing on a shipping route characterized by imbalanced container flows, an underutilized off-peak bus service and the one person per car situation in commuter traffic.

Traffic congestion is a problem that faces all countries, especially in large cities like Abuja metropolis and at certain peak times. This problem has grown at an alarming rate as our lives have become increasingly dominated by the car. Sitting in a traffic jam is both time wasting and frustrating and it is not motorist that suffers. Congested streets make life less pleasant for the pedestrians and increased traffic leads to accidents and significant problems of pollution in the F.C.T. Traffic congestion tends to increase travel time, arrival unreliability, fuel consumption, pollution emissions and driver stress, and reduce life satisfaction.

Numerous studies have demonstrated that traffic congestion has unfavorable impacts upon the society and economy of Nigeria. However, F.C.T. has experienced major developments in recent years, leading to an increase in the need for advanced transportation systems.

Consequently, the road is believed to be incapable of handling the amount of traffic on the roads during peak hours. Hence, the objective of this paper is to provide an in-depth understanding of the key factors directing the occurrence of traffic congestion in the Federal Capital Territory, Abuja.

To date, most of the studies conducted by transport economists such as (Vickrey (1954). Roth (1965), Gillen (1977-1978), Shoup (1982, 1987),Shoup and Willson (1992), Glazer and Niskanen (1992), Verhoef, Nijkamp, and Rietveld (1995), Calthrop, Proost, and van Dender (2000)). But their approaches ignores the microscopic of demand and supply related traffic congestion approach. However, a simple economic concepts or approach of demand and supply was used to understand traffic congestion and this will fill the gap.

2. Conceptual and Theoretical Review

2.1 Traffic Congestion

Rodrique et al, (2009) states that congestion can be perceived as unavoidable consequences of scarce transport facilities such as road space, parking area, road signals and effective traffic management. They argue that urban congestion mainly concerns two domains of circulation, passengers and freight which share the same infrastructure. Thus, traffic congestion condition on road networks occurs as a result of excessive use of road infrastructure beyond capacity, and it is characterized by slower speeds, longer trip hours and increased vehicular queuing.

Rodnique et al. (2009), note that congestion in urban areas is dominantly caused by commuting patterns and little by truck movement. This mean that traffic congestion are caused due to rise in population densities, road incidents and broken vehicles on the roads which restrict capacity of roads and impair smooth traffic flows. Another contributing factor to congestion as suggested by Herman (2001).

Broadstock (2011) and Pacione (2005), state that increasing wealth and high population, and availability of vehicle loan facility result in more car ownership than current transportation network can handle. It could be inferred from the above statement that there is a relationship between income level and car ownership and that the dominance of private car usage, particularly within cities, is likely to increase even further as a result of rise in household income with its attendant traffic congestion and high consumption of fuel.

2.1.1Transport Demand and Urban Congestion

The demand for transport is a derived demand, an economic term, which refers to demand for one good or service in one sector occurring as a result of demand from another. Users of transport are primarily consuming the service not because of its direct benefits, but because they wish to access other services. Transport needs, even if those needs are satisfied, fully, partially or not at all. Similar to transport supply, it is expressed in terms of number of people, volume, or tons per unit of time and distance.
Transport demand is about the movement of people and goods and in order to satisfy a need (work, education, recreation etc) and we transport goods as part of the overall economic activity.

So for example, work-related activities commonly involve commuting between the place of residence and the workplace. There is a supply of work in one location (residence) and a demand of labour in another (workplace), transport (commuting) being directly derived from this relationship, hence a derived demand. Transport can also be perceived as an induced or latent demand, that is a demand response to the addition of transport infrastructure results in traffic volume increases.

Although the essence of this demand is the mobilization of persons or things, it also has a traffic dimension, in terms of volumes of vehicles moving along the public roadways to carry out these objectives. The aforementioned concentrations of trips in the morning and afternoon generate an increase in the volume of traffic, known as peak times or rush hour, which translates into congestion on different streets and during different periods.

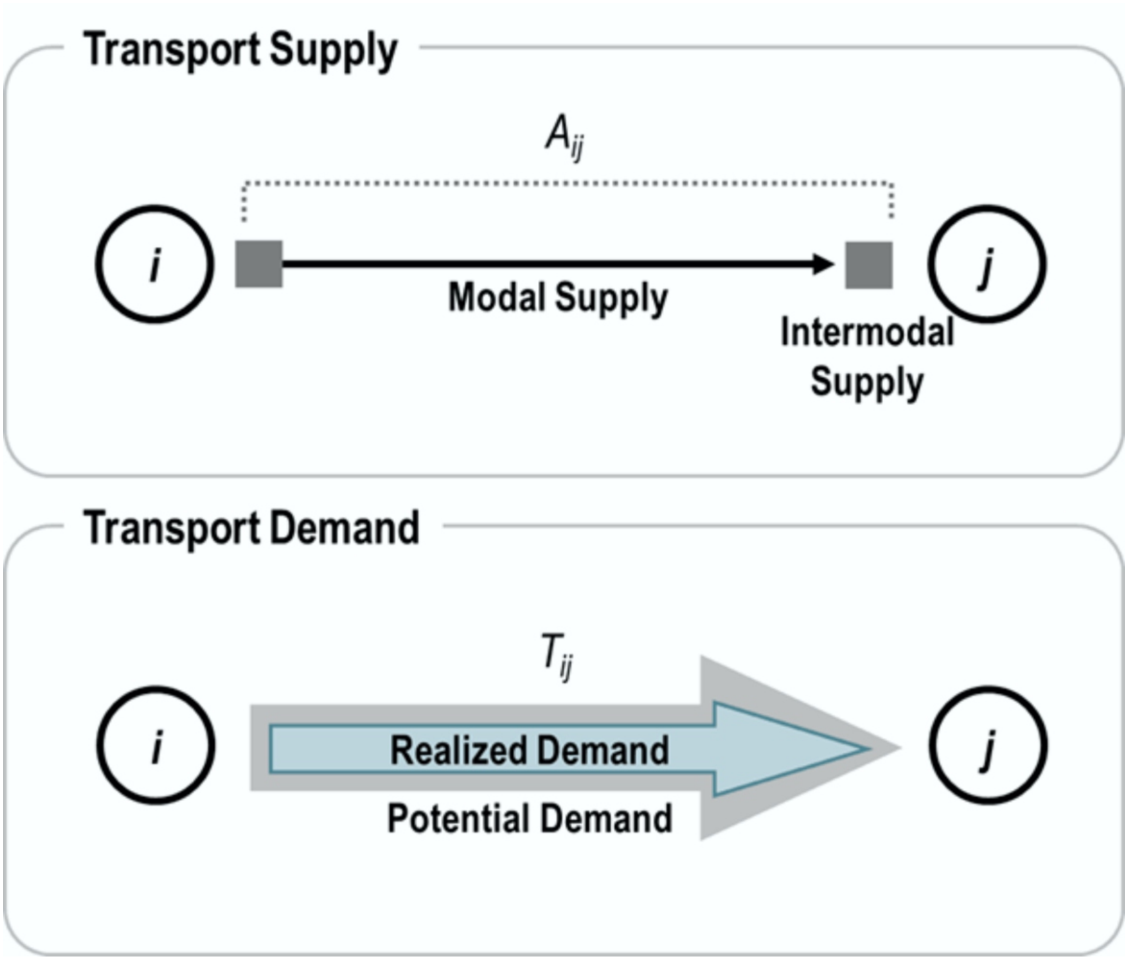
Urban transport demand tends to be expressed at specific times that are related to economic and social activity patterns. In many cases, urban transport demand is stable and recurrent, which allows a good approximation in planning services. In other cases, transport demand is unstable and uncertain, which makes it difficult to offer an adequate level of service. For instance, commuting is a recurring and predictable pattern of movements, while emergency response vehicles such as ambulances are dealing with an unpredictable demand that can be expressed as a probability.

2.1.2 Transport Supply and Urban Congestion

Transport supply is the capacity of specific transportation infrastructures and modes over a time period. Transport demand are mobility needs for the same time period, even if they are only partially satisfied. The capacity of transportation infrastructures and modes, generally over a geographically defined transport system and for a specific period of time. Supply is expressed in terms of infrastructures (capacity), services (frequency) and networks (coverage).

Capacity is often assessed in static and dynamic terms where static capacity represents the amount of space available for transport (e.g. terminal surface) and dynamic capacity are the improvement that can be made through better technology and management. The number of passengers, volume (for liquids or containerized traffic), or mass (for freight) that can be transported per unit of time and space is commonly used to quantify transport supply.

Urban transport supply tends to be categorized according to its capacity, that is, the number of persons who can be transported in a given period of time. Just from the infrastructure standpoint, capacity is usually measured as the number of vehicles that can circulate in a given area in a certain period of time; this parameter is meaningful when analyzing congestion, but it should not be forgotten that what really matters in a city is allowing people to move around satisfactorily.



Source: (Jean-Paul & Theo,2018)

2.1.2 Causes of Traffic Congestion

Traffic congestion occurs when a volume of traffic ormodal splitgenerates demand for space greater than the available street capacity; this point is commonly termed saturation. There are a number of specific circumstances which cause or aggravate congestion; most of them reduce the capacity of a road at a given point or over a certain length, or increase the number of vehicles required for a given volume of people or goods. There are principally two factors causing traffic congestion, namely micro-level factors, including the high number of people on the roads at the same time, and the overflow of vehicles on the limited road space; and macro-level factors, such as land use patterns, car ownership trends, and geographical economic development. Congestion is prompted at the micro-level, and steered at the macro-level (Tilak& Reddy, 2016).

Some of the factors causing traffic congestion are listed below:

Excessive number of vehicles in the city
Population increase
Inefficient public transport service
Inefficient roads and streets management
Poor roadway condition
Urbanization and
Unforeseen circumstances

Negative Effects of Traffic Congestion

Traffic congestion has a number of negative effects:

Wasting time of motorists and passengers ("opportunity cost"). As a non-productive activity for most people, congestion reduces regional economic health.

Delays, which may result in late arrival for employment, meetings, and education, resulting in lost business, disciplinary action or other personal losses.

Inability to forecast travel time accurately, leading to drivers allocating more time to travel "just in case", and less time on productive activities.

Wasted fuel increasing air pollution and carbon dioxide emissions owing to increased idling, acceleration and braking.

Wear and tear on vehicles as a result of idling in traffic and frequent acceleration and braking, leading to more frequent repairs and replacements.

Stressed and frustrated motorists, encouraging road rage and reduced health of motorists

Emergencies: blocked traffic may interfere with the passage of emergency vehicles traveling to their destinations where they are urgently needed.

Spillover effect from congested main arteries to secondary roads and side streets as alternative routes are attempted ('rat running'), which may affect neighborhood amenity andreal estateprices.

Higher chance of collisions due to tight spacing and constant stopping-and-going.

2.2 Theoretical Framework

The theoretical interpretations of this study were reviewed below:

The Estraus and Verdi Models

2.2.1The Estraus Model

Estraus (1997) is a model that balances transport supply and demand. It is applicable to multimodal urban transport networks with many different types of travelers (as a function of their income, the purpose of their trips, or other factors).

Travelers are classified according to the socioeconomic attributes of the household they belong to; for this purpose, average income and the number of vehicles owned are taken into consideration. The model assumes that in choosing among different available modes of transportation travelers apply a number of criteria, including costs, travel time and subjective preferences for one over another.

The multimodal network encompasses

single modes of transportation, such as car, bus, taxi or subway, and combined modes, such as bus-subway, car-subway, etc. The model incorporates capacity restrictions for both private and public transportation, which allows it to treat congestion explicitly. It also incorporates the cost functions that exist on arcs (stretches of road) in the network.

In other words, ESTRAUS delivers a complete representation of the urban transport system and all of its essential characteristics.The analyses are carried out for two periods during the day: i) the morning rush hour, from 7:30 a.m. to 8:30 a.m., and ii) off hours, between 10:00 a.m. and 12:00 noon. The morning rush hour is when the urban transport system has the most unfavourable operating conditions, in terms of the number of trips by motor vehicle and the amount of congestion. The importance of dealing with this period correctly is fundamental, considering that transport systems are designed to meet the demand for travel that occurs at that time, in terms of motorway capacity and public transit fleets.

2.2.2 The Verdi Model

Verdi (1999) is an evaluation model that analyses the economic impacts of a given intervention in the urban transport system. Verdi uses the results derived from ESTRAUS for base and "with project" situations (figure1). The differences between the two make it possible to calculate the costs and benefits of the project associated with the simulation periods of the Estraus Model.

Using expansion coefficients, it is possible to represent an entire day and year on the basis of the periods simulated with Estraus. Repeating the exercise for successive years, the measures under study can be evaluated socially or privately. The principal indicator considered is the net present value (NPV).
Verdi includes two options for the social evaluation of projects, called:

Classic evaluation, or resource savings

- evaluation, and
- Evaluation of benefits to travelers.

3.3 Methodology

A descriptive approach was adopted in this study. The study used survey research design. Primary data was collected using questionnaires. Commuters working in both public and private sectors within Abuja Metropolis and drivers that use passenger vehicles constituted the study population.
The population for this study included drivers that use passenger vehicles (taxis and mini-buses) that ply the roads within Maraba-Nyanya axis and commuters within Abuja metropolis. It was realized that using all the roads in the F.C.T. for the study would present practical difficulties. In view of this, the researchers sampled one key road link (Mararaba – Nyanya and AYA) was used. Since it was impossible to construct a sample frame for the drivers and commuters, the researchers used both quota and purposive sampling techniques were used in this selection to enable the researchers' select road links with high traffic congestion records.

These groups were purposively targeted with the view that they could provide relevant information in relation to the research question since they constitute major stakeholders in passenger transportation within the city.

Based on this, the three road links under this study in which the vehicles ply them, a quota of one (100) drivers of passenger vehicles was allocated to each of the five roads to make a sample size of 300 for the drivers.

The quota distribution rate for each road comprised of forty-one (41) taxi drivers and nineteen (19) mini bus drivers. This is presented in table 3. The respondents from each category were selected using systematic random sampling based on every third driver met at the terminals. The drivers were given higher quota than the commuters due to the technical information required which could best be provided by

them.
As stated earlier, hundred and fifty (150) commuters working in both public and private sectors were involved in the study with a quota of thirty (30) from each road. The 50 respondents from each road links were also selected randomly so that each has an equal chance of being selected. Thus making for a total respondent of four hundred and fifty-five (450).

4.4 Results and Discussions

	Category of Respondents
Category	Sample size
Drivers	300
Commuters	150
Total	450

Source: Researcher's field work (2018)

Table 1 shows the categories of the respondents on the basis their sample size. Drivers on the average has 300 sample size while commuters based on the surveyed has 150 making a total of 450(67% and 33%) respectively and this signified excessive cars in the F.C.T.

Table 2

		Sample and Response Rate	
	Respondents	Sample Size	Response Rate
	Drivers	300	300(100%)
	Commuters	150	150 (90%)
	Total	450	450(96.7%)

Source: Researcher's field work (2018)

Table 2 shows the response rate of the respondents with drivers having 100% and commuters having 90%. It was identified that on the average of the total responses rates 450 (96.7% acknowledged that congestion increased the operating costs of bus transport by up to 50%(drivers) while the commuters identified a significant increase of transportation fares 50% at rush hours, and late arrival to work .

Table 3
MARARABA NYANYA: ESSENTIAL CHARACTERISTICS OF TRANSIT DURING MORNING RUSH HOUR (7:30 a.m. TO 8:30 a.m.)

Number of trips	2017	A 2018	Change 2017-2018
	1 208 056	1 469 297	+ 22%
Total distance travelled (km)	10 411 568	13 209 551	+ 27%
Total time taken (hours)	702 021	1 254 441	+ 79%
Trips by bus (percentage)	52.4	47.1	- 5.3 %
Trips by car and taxi (percentage)	27.5	35.8	+ 8.3%
Trips by subway Average bus trip	4.2	4.7	+ 0.5%
Total distanceb (km)	9.7	9.8	+ 1.0%
Total timeb (minutes)	48	70	+ 46%
Speed of bus (km/h) Average car trip	16	9	- 44%
Distance (km)	9.5	9.8	+ 3.2%
Time (minutes)	22	39	+ 77%
Speed (km/h)	26	15	- 42%
Congested stretches	140	735	5.3 times

Source: Researcher's field work (2018)

Based on the table 3 the following conclusions can be drawn about the morning rush hour from:

- The total number of trips made will increase at an average rate of 2.5% a year, or a cumulative 22% over the entire period.
- The total distance travelled by all vehicles will increase by 27%, while the total time taken will rise 79%.
- Although buses will account for the majority of trips, the modal distribution will change in favor of cars, and the subway will still account for less than 5%.
- Trip indicators suggest a major increase in congestion if corrective measures are not taken. Thus, an average trip by car for approximately
- the same distance will take 77% longer, whereas an average bus trip will take 46% longer.
- Although the rise in the number of trips and distances travelled appears moderate, all service indicators, especially speeds and travel times, will be significantly worse.
- Congestion levels in certain areas and streets of the city will become more severe and the sphere of influence will gradually expand, such that the number of congested stretches of roadway will quintuple. This is why a combination of measures aimed at controlling congestion must be considered.

Table 4

AYA- NYANYA- MARARABA: RELATIVE INCOMES OF USERS OF DIFFERENT MEANS OF TRANSPORT, 2018.

Means of transport (Private cars = 100)	Relative income of travelers
Bus only	55
Private car only	100
Taxi only	91
Metro only	89
Combination bus+bus	50
Combination bus+metro	62.5
Total	

Source: Researcher's field work (2018)

Congestion obviously causes bus passengers to take longer time to complete their journeys. These longer journey times are a loss in real terms, although perhaps this does not attract so much attention because these passengers have relatively low incomes, so that their personal time is assigned a low monetary value.

Table 4 indicated the relative incomes of different means of transport - AYA, NYANYA and MARARABA axis of the F.C.T. with Bus users having an average income of 55, , for taxi users as 91. while combination of bus and metro is estimated at 62.5 and income of private car users was over three times that of bus passengers 100.

Plate I and II

The Selfish and Undisciplined Behaviour of Motorists in Mararaba – Nyanya road link

Source: Mararaba – Nyanya Road Axis (2018)

Plates I and II shows the behaviours of some selfish and undisciplined motorists in Mararaba – Nyanya road links who show little respect for other road users. In the capital city, many drivers try to cut a few seconds off their journey times by forcing their way into intersections and blocking the passage of other motorists, thus causing economic losses to others which are much greater than their own gains.

It is a tradition for buses to stop immediately before an intersection, thereby causing congestion (and accidents). In those same cities, as in others that have an excessive number of taxis that do not habitually operate from fixed taxi ranks, these vehicles crawl along looking for passengers, and this also gives rise to congestion. In addition to these practices, the traffic flows also often include old and poorly maintained vehicles.

It must be borne in mind that when the traffic flow resumes after being stopped at a traffic light, a form of congestion ensues because vehicles with a normal rate of acceleration are held up by slower vehicles located in front of them. Furthermore, a vehicle which is stopped or moving sluggishly seriously affects the smooth flow of traffic, since in effect it blocks a traffic lane. Reduces the capacity of the road system to a fraction of its real potential.

Some vehicles cause more congestion than others. In transport engineering, each type of vehicle is assigned a passenger car equivalence called a pcu, or passenger car unit. A private car is equivalent to 1 pcu, while other vehicles have equivalencies corresponding to their disturbing influence on the traffic flow or the space they occupy in it, as compared with a private car. A bus is normally considered to be equivalent to 3 pcus and a truck to 2 pcus. Strictly speaking, however, the pcu factor varies according to whether the vehicle in question is close to an intersection or is in a stretch of road between two intersections.

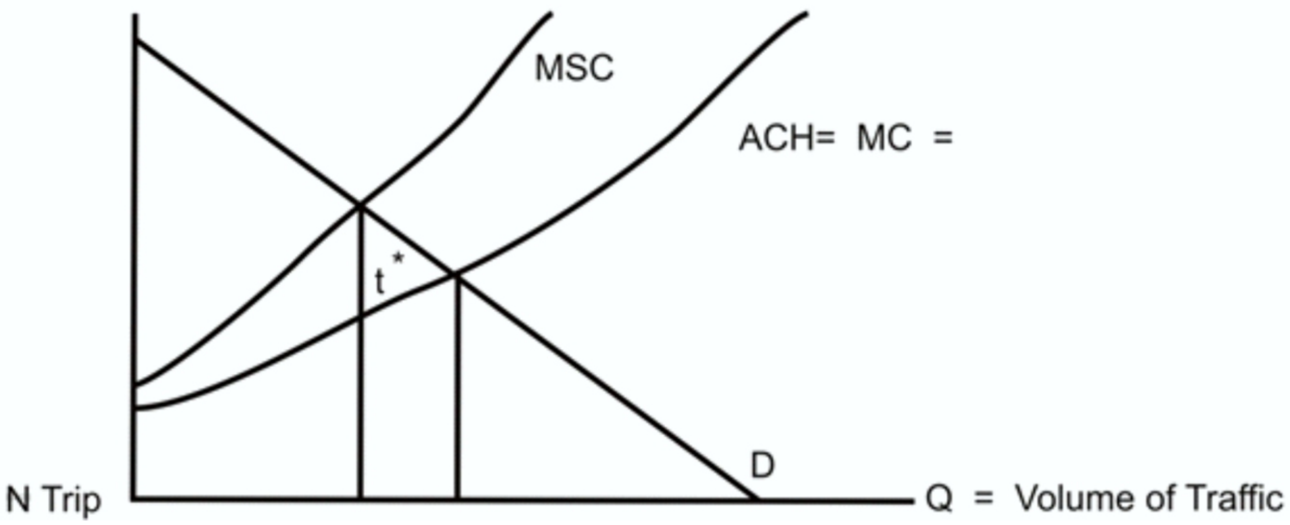


Figure1. Diagramatic representation of the basic model of trafic congestion

Congestion is captured by a congestion cost function which relates trip cost to traffic volume and capacity.

Figure 1 gives a diagrammatic representation. *D* is the demand curve; *AC* relates each driverGs trip cost to traffic volume, *Q,* and is variously referred to as trip cost, average cost, user cost, and marginal private cost; and *MSC* is the marginal social cost of a trip. In the absence of government intervention, the equilibrium occurs where demand intersects average cost. The optimum occurs where demand intersects marginal social cost. The vertical distance between *MSC* and *AC* is the congestion externality cost. The minimal government intervention needed to decentralize the social optimum is the imposition of a congestion toll equal to the congestion externality cost, evaluated at the social optimum.

The demand for highway transportation represents the value that consumers place on traveling in a particular time, manner, and place, as measured by their willingness to "pay" for a trip. Some trips will be valued very highly, whereas others will be valued much less so. This relationship between the cost of travel and the level of demand for travel is commonly depicted as the travel demand curve (Figure2).

The travel demand curve slopes downward, reflecting a basic economic truth: As the price of a good or service falls, the quantity that will be demanded increases, holding other factors constant. The demand for travel is no different: When the price of travel is high (in the generalized user-cost sense described above), fewer people will be willing to make fewer trips; when that price falls, there will be more people willing to make more trips.

The demand curve is characterized by two important qualities: its level and its shape. The level of demand (i.e., the position of the demand curve) is affected by a number of factors. For example, each trip has an origin and a destination. The more people there are at a particular origin and the more activities (e.g., shopping or employment) there are at a particular destination, the more will routes between the origin and destination be in demand for travel. As income levels rise, the willingness to pay for travel also increases, shifting the demand curve outward.

Demand levels can also vary significantly (and importantly for the discussion here) by time of day, due to the simple fact that people prefer to sleep at night and be active during the day, leading to higher levels of demand for travel in the morning and early evening and lower levels of demand during mid-day and overnight hours. Finally, subjective qualities such as comfort and convenience can affect the level of demand.

The responsiveness of the quantity of travel demanded to changes in the price of travel is measured by *travel demand elasticity.* Mathematically, it is simply the percentage change in quantity demanded divided by the percentage change in price.

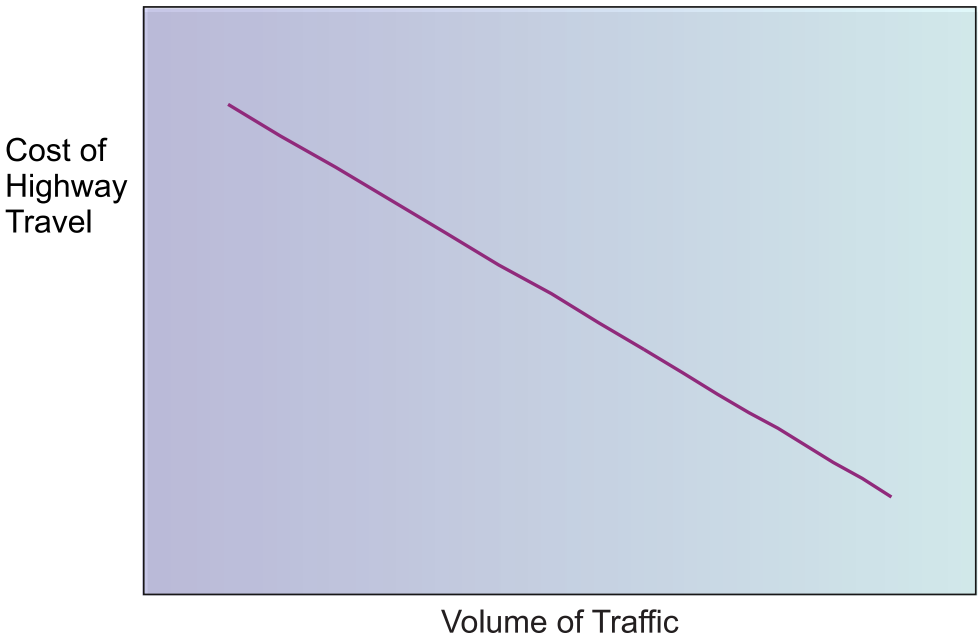


Figure 2. The travel demand curve.

Intuitively, elasticity represents the shape of the demand curve. If the quantity demanded changes significantly in response to small changes in price, demand is said to be relatively elastic; thus, the demand curve is fairly flat. Conversely, if demand changes only slightly in response to large changes in price, demand is said to be relatively inelastic; thus, the demand curve will be relatively steep. At the extremes, demand can be said to be perfectly elastic (i.e., any change in price results in an infinite change in quantity demanded) or perfectly inelastic (i.e., any change in price results in no change in quantity demanded).

The elasticity of demand also depends on a number of factors. Perhaps most important is the timeframe being considered: Demand is typically less elastic in the short run than in the long run. When the price of travel changes significantly, travelers initially have relatively few opportunities for adjusting their behavior. They may decide not to make some trips or to change their mode of travel to work, but their housing and employment locations, key determinants of the level of travel, are likely to remain fixed initially. In the long run, however, everything is variable. People may choose to move closer to their work or take jobs closer to home. Commercial real estate development patterns may also respond to reduce the distance between consumers and activity centers. As a result, the longterm impact of an increase in travel costs on the volume of highway may be much higher than the short-term impact.

The elasticity of demand is also affected by the quality and availability of close substitutes. For example, if two companies make very similar products, then consumers are likely to readily switch from one product to the other in significant numbers if the price of one of the products changes, resulting in high-demand elasticity for each product. Conversely, if there are no good substitutes for a good or service, then consumers might simply be faced with a choice between paying a higher price or going without, in which case demand is likely to be inelastic.

Traffic engineers typically characterize traffic flow as a relationship between travel speeds, traffic volumes, and traffic density (e.g., number of vehicles occupying a given space on the road). Figure 3 shows the general shape of these relationships.

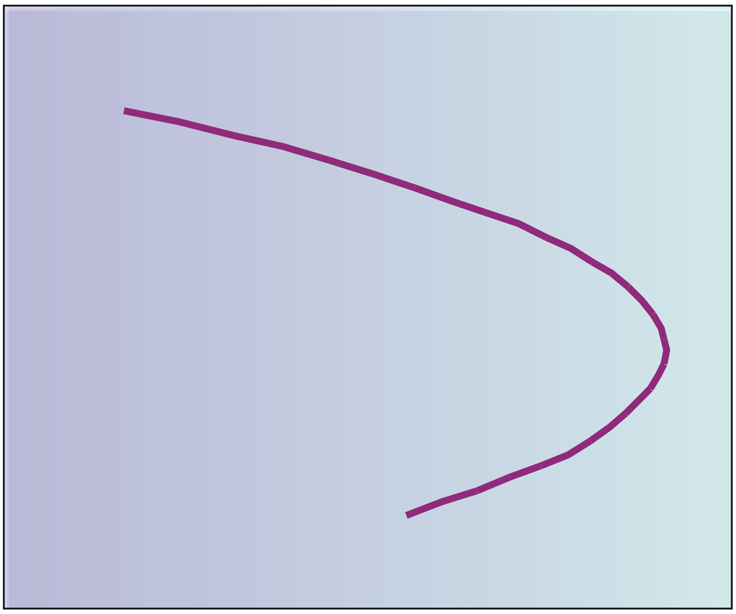
Volume–Density When traffic volumes are very low, vehicles have minimal impact on one another, and their travel speeds are limited only by traffic-control devices and the geometry of the road.

As traffic volumes increase, however, traffic density increases, and the freedom for vehicles to maneuver is more constricted. As a result, travel speeds begin to decline, relatively slightly at first, but falling significantly as traffic volumes approach the maximum capacity (service flow rate) on the facility. As traffic density continues to increase beyond this saturation point, the speed–volume relationship actually bends backward, as traffic flow breaks down and fewer vehicles are able to get through.

The decline in travel speeds as traffic volumes approach roadway capacity, of course, is what we all know as *congestion delay*. The important implication of this is that there will be a relationship between highway-user costs and traffic volumes on a particular road. At lower volumes, user costs will be relatively constant with respect to volume. As traffic volumes increase, however, user costs will eventually begin to rise at an increasing rate; the point at which this occurs depends on the capacity of the road (see figure 3).

Speed–Volume

Speed (Miles/hour)

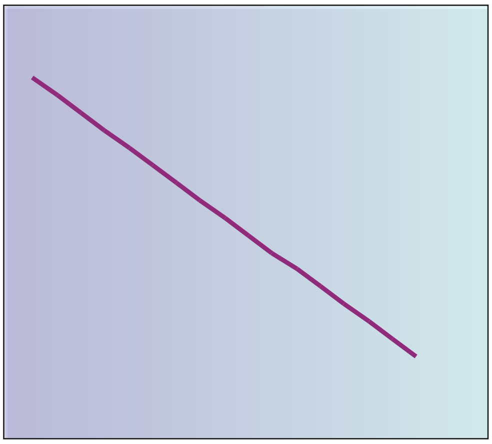


Volume (Vehicles/mile) cost

Curve.

This relationship is sometimes referred to as a generalized user

Speed–Density



Density (Vehicles/Mile)

Cost of Travel

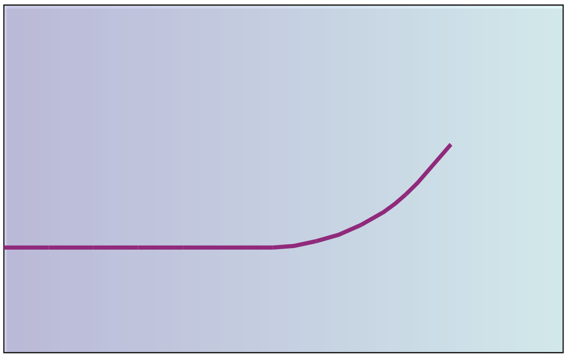
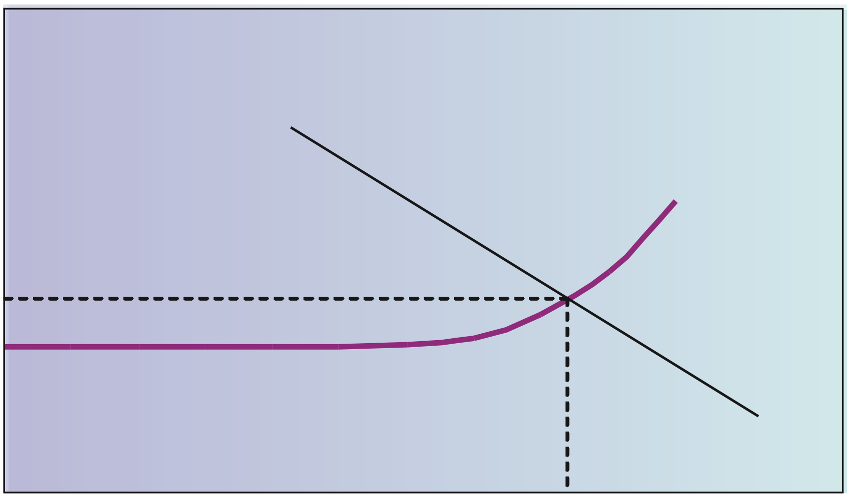


Exhibit 3. Generalized user costs and traffic volumes

Figure4. Equilibrium user costs and traffic volumes. P = price. V = volume.



When supply and demand are in balance, a market is said to be in *equilibrium*. This is often represented as the intersection of a supply curve and a demand curve, which determines the market clearing price and quantity (see figure 4). At this point, everyone who purchases the good is willing to (collectively) buy that amount at that price, and producers are willing to supply that quantity at that price. If either the supply or demand curves shift, the market price and quantity will also change.

For highway travel, demand is determined as described above. The "supply" curve, however, is essentially represented by the generalized cost curve. The intersection of these two curves determines how high traffic volumes will be and what the associated average highway-user costs will be at that volume level. When the level of demand is low relative to the capacity of the road, it will be uncongested, and prices will be relatively constant even as volumes increase (the "flat" part of the user cost curve in Exhibit 4). However, when demand levels are high and the road is congested, both user costs and traffic volumes will be higher, potentially rising sharply as demand continues to increase.

Table 5 Abuja Cities: Increase in Operating Costs of Public Transport Due to Traffic Congestion (Effects)

Municipal/City	I Increase in bus operating costs due to congestion
Garki	6.2
AYA	0.9
Nyanya	6.4
Mararaba	1.6
Area 11	3.7
Federal Secretariat	2.1
Zone 2-3	3.5
Area 1	9.6
Wuse	15.8

Source: Researcher's field work (2018)

$\frac{49.8}{450} \times 100 = 11.4\%$

450 response rates.

Table 5 shows the average increase in operating costs of public transport due to traffic congestion

effect of both public and private car owners as well as commuters by the survey. It was identified that both public and private vehicle owners as well as commuters in the Abuja have an average of eleven (11%) operating costs of public transport due to traffic congestion across the city centers. This and other findings revealed that congestion is too serious and far-reaching a problem to believe that it can be relieved through unilateral, erratic or voluntaristic measures.

In these areas, the greater accessibility created by the subway leads to the construction of office buildings that workers can reach easily on subway trains.

5.1 Conclusion

In conclusion, the study revealed that traffic congestion, especially in the big cities, is an increasingly widespread problem all over the F.C.T. The enormous and growing costs caused by it in terms of loss of time and vehicle operation make it essential to find an alternative ways and means of tackling it. In other word, keeping it under control and ensuring a minimum of sustainability of urban standards of living calls for a multidisciplinary effort which includes the improvement of driving habits, the provision of better infrastructure, and measures to manage traffic (supply-side management) and rationalize the use of public roads (demand management).

5.2 Recommendations

- Greater utilization of modes of transportation with a high occupancy coefficient, including carpooling;
- Shifting of car travel from peak hours to off-peak hours; and Travel on foot or by bicycle.
- Controlling on-street and off-street parking;
- Staggering or spreading out work, school and business schedules;
- Restricting the circulation of certain vehicles or prohibiting certain vehicles at certain times;
- Road pricing using electronic and non-electronic collection methods;
- Methods and situations that alleviate congestion by means of instilling personal convictions and reducing the need to travel.
- Rectification of intersections
- Improvement of road markings and signs
- Rationalization of on-street parking
- Staggering of working hours
- Synchronization of traffic lights
- Reversibility of traffic flow direction in some main avenues
- Establishment of segregated bus lanes, together with the restructuring of the system of bus routes

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