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ECONOMIC IMPLICATIONS OF CONGESTION AND TRAVEL TIME VARIABILITY ON COMMUTERS

Henry Ojo. Owogbemile¹, Funsho Idowu. Obakemi²

¹Department of Economics, University of Ilorin, Nigeria, +2348036375281,
owogbemilehenryojo@gmail.com

²Department of Economics, University of Ilorin, Nigeria, +2348035672694,
obakemifunsho@gmail.com*

Abstract:

This study examines the economic implications of traffic congestion and travel time variability on the productivities of commuters in Ilorin, Nigeria. The study covered three routes (Maraba, Amilegbe and University) at the peak periods of morning (7:00am-9:00am) and evening (4:00pm-6:00pm). A total of 450 commuters were sampled equally from the three routes, and 396 (89%) were returned valid. Descriptive statistics were employed in analysing the data collected. The major factors found responsible for congestion on the selected routes are inadequate road capacity, illegal on-street parking, poor driving habit, encroachment on the right of way, too many taxis/buses and poor traffic control management. While the effects are lateness to work and school, tiredness, hike traveling cost and pollution. The implication of these is that excessive travel delay, particularly during peak hours negatively affect commuters' productivity. The study therefore recommends a strict implementation of policies through the town planning authorities with strict adherence to erections of retail stall on the right of way. Functional, fast, affordable and reliable mass transit which can convey a large number of people should be provided by the government or employers to replace the use of taxicab as this will provide sustained relief on our roadways.

Key words:

Traffic congestion, Travel time variability, Productivity, Commuters, Externality

INTRODUCTION

One basic economic and social necessity that comes into focus when discussing economic and social development is transportation. This emanates from the fact that without adequate facilities for moving goods and people from source to destination, economic and social activities could be paralyzed. Transportation is an activity of life processes and seeks to provide access to various activities that satisfy mobility needs of humankind [5]. An effective transportation system is significantly important in sustaining economic growth in contemporary

economies since it provides linkages between different parts of the country and the global world. It links home to work, deliver products to market, underpins logistics and supply chain, and support local and international trade [26]. It is also a means to access business activities, education, employment and recreational opportunities, thus contributing to policy effectiveness and enhancement of security through reduced isolation as well as providing job opportunities [27].

The most commonly used mode of transportation has been found to be road transport because of its universality. [10] opined that road transportation is a critical link between all the other modes of transportation and their proper functioning. It is the vital sign of industrialised economies. Road network constitutes an important element in urban development as it makes all places accessible for the commuters [22]. However, one major problem that increases the inaccessibility of roads today is traffic congestion. Due to incessant increase in population, increase in household incomes and its resultant increase in the level of car usage coupled with poor land-use planning, poor transport design and planning, traffic congestion has become an intractable problem in urban centres in Nigeria [2].

It has remained one of the unavoidable problems of road transportation since it may be very difficult, if not impossible for traffic congestion to be totally eradicated in economically buoyant urban areas most especially at the peak periods [15]. Though, it can be well managed in term of reduction in its excessiveness. [6] posited that traffic congestion is not primarily a problem, but rather the solution to our basic mobility problem, which is, too many people want to move at the same times each day. Because efficient operation of the economy systems requires that people access social economic places such as work, school, health facility, market, tourist centres and even run errands during the same hours so they can interact with each other. These are imperative for economy growth dynamism.

However, traffic congestion tends to defy various remedial measures employed by different governments over the years [17]. It causes significant increase in undesired long delays, adverse pollutions, increased operating costs and adverse sociological effects [9]. It wastes time and energy, causes stress, decreases productivity and imposes costs on society equal to 2-3% of our GDP [5]. [3] found that majority of commuters and motorists spend between 30 to 60 minutes on the road due to traffic congestion. Lateness to the offices, work places or on any scheduled appointments, mental disgust, exhaustion and loss of effective man hours constitute colossal drain on the resources of the whole country. Economic and environmental losses resulted from this severe traffic obstruction may be difficult for a developing country like Nigeria to afford.

Therefore, arising is the obvious need to pay serious attention to core economic implications of traffic congestion such as loss of productive time and income and higher transport fares which subsequently lead to higher cost of living for the commuters. It is on this note that this study examines the economic implications of congestion and travel time variability on commuters on some selected roads in Ilorin. However, what are the causes of congestion? What are the effects of congestion on the productivities and income of the commuters? Answers to these questions are the focus of this study.

1 LITERATURE REVIEW

Traffic congestion occurs in a situation when the road system does not have enough capacity to handle peak-hour loads without forcing people to wait in line for limited road space. It is a situation when traffic is moving at speeds below the designed capacity of a roadway, because the number of vehicles trying to use a road exceeds the design capacity of the traffic network to handle them [6] & [26]. The effect of traffic congestion on commuters covers demand capacity, delay-travel time and cost related. Congestion assumes two forms; recurrent and non-recurrent. The former is generally the consequence of factors that act regularly or periodically on the transportation system, such as daily commuting or weekend trips. Mandatory trips are mainly responsible for the peaks in circulation flows, which means most of the congestion in urban areas in Nigeria, are recurring at specific times of the day and on specific segments of transport system. This is true for the roads under study. While non-recurrent congestion is the effect of unexpected, unplanned or large events (e.g. road works, crashes, special events and so on) that affect parts of the transportation system.

[7] attributed the causes of congestion to excess vehicles, land use patterns, employment patterns, income levels, car ownership trend, infrastructure investment, regional economic dynamics etc. The previous studies led credence to ECMT on the cause of traffic congestion. [20] found population and urbanization and growth of vehicle ownership as the drive of propensity-to-travel. In the same vein, [8] attributed recurrent traffic congestion to excess demand for travel and shortage of infrastructure supply, while non-recurrent to unexpected events such as accidents or other emergency events. Similar study by [12] found traffic signaling systems, inadequate manpower, narrow road spaces and overtaking tendency of drivers as core causes of traffic congestions. [1] found traffic wardens and parking problems to be the core causes of traffic congestion. [19] found inadequate road capacity, poor road pavement, poor traffic management, poor drainage system poor driving habit and poor parking habit.

[26] affirmed the wide range of negative effects of congestion on business economy, air quality and quality of life. [16] discussed the adverse effects of traffic congestion to include lateness to school which in turn contributes to students' poor performance; lateness to work and increased sensitivity towards closing early from work leading to reduction in the output of workers and consequently a distortion in the developmental process and prospect. It increases fuel consumption by vehicles, which leads to increase in transportation cost for carriage of commodities and passengers. This adversely affect household budget, cost of running business and prices of goods.

[20] showed that congestion increases the tendency of vehicles collision which may lead to rise in maintenance cost. In a similar vein, [19] concluded that time wasting, delayed movement, stress, accident, inability to forecast travel time, fuel consumption, road rage, relocation, night driving, and environmental pollution are all the effects of road congestion. [21] established inverse relationship between traffic congestion and workers' productivity and estimated \$8000 as cost of delay per individual in one year in Nigerian major cities. Similar

study by [14] in Northern New Jersey showed that bus travel time rates (in minutes per mile) increase proportionally with car travel time rates.

As earlier said, completely eliminating congestion is not a practical option, this is not to say that cities should not proactively and vigorously address growing congestion – they should, especially in cases where congestion can be linked to specific traffic bottlenecks and cost-effective measures are available. However, in the long run, what matters most is how congestion can be managed such that the beneficial outcomes of agglomeration are not eroded unacceptably by the negative impacts of congestion (ECMT, 2007). From the empirical studies reviewed, studies on the link between traffic congestion and economic loss are very scarce. This study tend to fill this gap by looking into the economic implication of traffic congestion and travel variability in Ilorin metropolis, Nigeria.

2 THEORETICAL FRAMEWORK

This study is rooted on the theory of externality. From the economic point of view, traffic congestion is a classic example of the overuse of a common resource [4]. It occurs when road is overused. Road users, who ignore the impacts imposed on other users tend to overuse the road inefficiently as their perceived private cost is less than the trip benefits [8]. Since roads in most places are free at the point of usage, there is little or no financial disincentive for drivers not to over-use them, up to the point where traffic collapses into congestion. Thus, traffic congestion is an externality.

Externality refers to unconsidered cost or benefit experienced by a third party due to economic decisions made by others. Traffic congestion always exerts negative externalities upon society [13] and this causes the market price mechanism to fail in achieving its efficiency. The essence of this theory of cost is based on the fact that, when making a journey by car, a motorist only considers the marginal private cost (MPC). This is the cost directly attributable to him/herself, such as time, fuel and maintenance of the vehicle, rather than marginal social cost (MSC), which is the summation of MPC and marginal externality cost (MEC). MEC are costs imposed on the society inform of pollution, noise, accident, road rage, vibration, severance and time lost due to congestion.

The Fig. 1 indicates the relationship between the cost of travel and the flow of traffic along a particular route. This study assumed that, when making a journey, congestion is the only externality. Under a free flow traffic, the equilibrium number of trips on the road should ideally occur at point A; where the MPC equals MSB at traffic flow T_0 (i.e. the private cost to the motorist will be A). At a flow of T_0 , the external cost not taken into account by the motorist is AC, which is the difference between the MPC and MSC.

This means that resources are not being allocated efficiently and that individuals are making more journeys than they would if they were aware of the full social costs. Hence, in times of traffic congestion, the marginal social costs have to be taken into account; in this case, the socially optimal number of trips on the congested road now occurs at point B, where MSB equals MSC. This leads to decrease in the number of trips on the road from T_0 to T_1 and brings

a deadweight loss shown by the shaded triangle ABC. This deadweight loss in fact are costs to everyone in the society resulted from slowing traffic flow in the congestion.

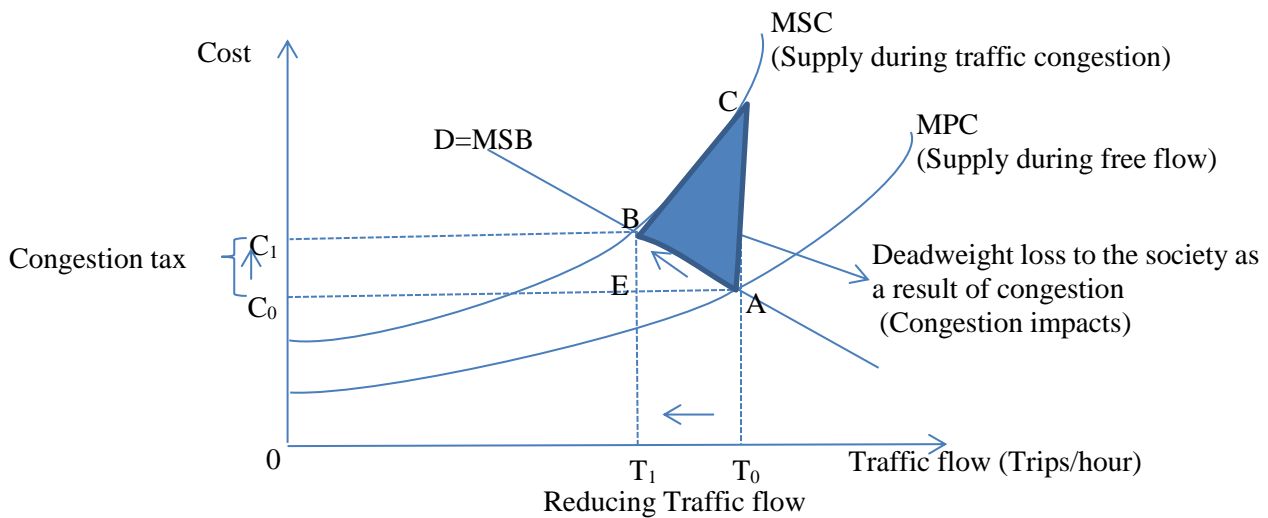


Fig. 1 Relationship between the cost of travel and the flow of traffic

[18] therefore, proposes to internalize the external cost by charging it as a tax to whoever causes it. Imposition of the toll raises social surplus by an amount equal to the shaded area *ABC* in Fig.1 Nevertheless, commuters end up worse off if the toll revenues are not used to benefit them. The T_1 individuals who continue to drive suffer a loss per trip of $C_1 - C_0$, resulting in a collective loss equal to area C_0C_1BE . And the $T_0 - T_1$ individuals who are priced off the road, either because they switch to another mode or give up traveling, suffer a collective loss equal to area EBA . These losses are the root of the longstanding opposition to congestion tolling in road transport [11].

3 MATERIALS & METHODS

The study covers three busiest routes (Maraba, Amilegbe and University road) at the peak periods of morning (7:00am-9:00am) and evening (4:00pm-6:00pm) in Ilorin, Nigeria. The choice of these roads is based on its location within the seat of government and the commercial hubs. And as such, they record high flow of human and vehicular traffic on daily basis. Only the single trip of the commuters were taken into consideration.

A well-structured questionnaire was used to collect data on the socioeconomic characteristics, causes of traffic congestion and effects of congestion on the productivities and income of the commuters along the selected routes. Purposive sampling technique was employed for this study and the sample frame consisted of all the commuters (Road users) on the three routes. A total of 450 respondents was randomly selected; 150 from each route. Out of this, 396 were returned valid which constitute about 89% of the total commuters interviewed.

¹Descriptive statistics of means and simple percentages were employed in analysing the data collected.

4 RESULTS AND DISCUSSION

Tab. 1 Socioeconomic characteristics of the commuters

Nominal Variables	Mean	Minimum	Maximum
Age	30.51	16	55
Household size	3.35	1	9
Monthly income (\$)	95.8	13.2	395

	Percentage
Gender	Male = 57.89%, Female = 42.11%
Marital status	Single = 43.51%, Married = 54.96%, Others = 1.52%
Level of education	Primary school completed = 0.79%, Secondary school attempted = 2.36%, Secondary school completed = 8.66%, Tertiary education attempted = 34.65%, Tertiary education completed = 51.97%, Others = 1.57%
Occupation	Student=25%, Civil Servants=38.28%, Informal Sector worker=15.63%, Organised private sector worker=20.31%, Others=0.78%

Source: Computed by the Authors

Table 1 reveals mean age of 31 years which implies that the average commuters are within the working age. More than half (57.89%) of the commuters are males, while 54.96% and 43.51% were married and single respectively, with an average and maximum household size of 3 and 9 members respectively. About 51.97% of the commuters had completed tertiary education, while 34.65% are still schooling in tertiary institution. This suggests that majority of the commuters along the selected routes are literate. The results further show that 74.2% belong to workforce, while 25% were students. This implies that majority of the commuters on these roads are relatively gainfully employed and they have to leave home early in the morning for work, of which traffic delay can have an enormous effect on their productivities. The commuters have a mean, minimum and maximum monthly income of ₦36417 (\$96), ₦5000 (\$13) and ₦150000 (\$395) respectively. The minimum monthly income of ₦5000 could be attributed to the pocket money received by some students who ply the routes.

¹ A dollar (\$) was exchanged for ₦ 380 when the survey was conducted

Tab. 2 Occurrence and frequency of traffic congestion

Variables/Parameters	Percentage
Frequency of travel	Monday only=7.69%, Tuesday only=1.54%, Wednesday only = 0.77%, Thursday only=0.77%, Friday only=5.38%, Every working day=83.85%
Purpose of travel	Work=50.51%, Business=18.32%, School=27.35%, Social activities=3.05%, Others=0.76%
Frequency of travel delay	Monday only=41.09%, Tuesday only=0.78%, Wednesday only=0.78%, Thursday only=3.10%, Friday only=13.18%, Every working day=41.09%

Source: Computed by the Authors

Table 2 shows that majority (83.85%) of the commuters travel every working day along the selected routes, 7.69%, 5.38% and 1.54% travel every Monday, Friday and Tuesday respectively, while 0.77% travel on Wednesday and Thursday respectively. With respect to the purpose of travel, Table 2 shows that 50.51%, 27.35% and 8.32% travel for work, school and businesses respectively. Only 3% ply the routes for social activities. This suggests that bulk of trips in the routes hinge on work and school. This is attributed to the fact that official resumption time for majority of workers as well as the students is 8a.m; it may not be unconnected to the fact that those roads services institutions like Kwara State Polytechnic main campus, University of Ilorin Teaching Hospital Maternity Centre and University of Ilorin permanent site.

Table 2 further reveal that 41.09% and 13.2% of the commuters experienced travel delay on every Monday and Friday respectively, 3.10% experienced traffic delay on Thursday. Least traffic flow is usually experienced on Tuesday and Wednesday. This is due to the fact that most workers who were at home for weekends resume work on Monday, couple with the belief of an average Nigeria; that Monday is the most important working day in a week, might be responsible for the worst congestion that occur on Monday. This agrees with the similar findings by [3] that the worst traffic congestion occurs on Mondays.

Tab. 3 Distance, travel time, cost of travelling and mode of transportation

Variables	Mean	Minimum	Maximum
Distance (Km)	4.18	1	10
Travel time (Minutes)	28.05	5	60
Cost of travelling (\$)	0.4	0.1	2.6
Mode of transportation	Walking=3.76%, Motorcycle=12.78%, Tricycle=3.76%, Personal vehicle=21.05%, Public vehicle=58.65%		

Source: Computed by the Authors

Table 3 reveals that the commuters have an average travel distance of 4km from home to their respective destination. An important factor behind this is related to residential affordability as housing located further away from commercial areas is more affordable. Though, this will increase the travel time and may have an effect on the output of those workers. As affirmed by [24], long distance commuting is found to impose a significant cost on workers' productivities

especially in the absence of reliable and cheap transportation technology which is essential for establishing long-distance commuting operations. The average travel time of 28 minutes which is in consonance with 20-40 minutes travel time as found by [23], is likely to increase with traffic congestion, and the higher the travel time, the lesser the time for other productive activities. It is argued that a longer commuting time may induce workers to arrive late at work or leave earlier which reduces productivity [28].

The mean, minimum and maximum traveling cost by commuters are ₦155 (\$0.4), ₦50 (\$0.1) and ₦1000 (\$2.6) respectively. This tends to increase with traffic congestion which adversely raise cost of living. Table 3 further reveal that majority (58.65%) use public vehicle while 21.05% use personal vehicle. Only (12.78%) use motorcycle while 3.76% use tricycle and walk respectively. The dominant use of public vehicles like Taxi-cab increases the number of vehicles on the road thereby causing traffic congestion.

Tab. 4 *Observable causes of congestion on these roads*

Factors	%	Factors	%
Increase in vehicles ownership	35	Lack of pedestrian facilities	21
Building conversion from residential to commercial use	25	Poor traffic control management	50
Encroachment on the right of way	55.3	Too many taxis/buses	55
Illegal on-street parking	65.2	Presence of heavy-duty trucks	23.2
Poor driving habit	59.4	Religious/other events along the road	27.1
Inadequate road capacity	67.2	Lack of overhead bridges/fly-overs	11.3
Poor road network	44.3	Accident	21.2
Poor drainage system	43.1	Break down of vehicles	11.3
Poor junctions/round-about design	26.3	Others	4.5

Source: Computed by the Authors

Results in Table 4 reveal the most severe causes of congestion to be inadequate road capacity (67%), which could as a result of obstructions from road side retailers' stand and port holes on some part of the roads; illegal on-street parking (65%) which may be due to lack of parking facilities. Also, drivers cut each other off, stop in the middle of the roads to pick passengers, and weave erratically across lanes; poor driving habit (59%), encroachment on the right of way (55%) due to illegal buildings and shops and erection of physical materials such as sign post; too many taxis/buses (55%), and poor traffic control management (50%) since all the traffic light in Ilorin have stopped working and the traffic wardens cannot get it right all the time; These tend to agree with earlier findings from a number of studies [1, 3 & 25]. Other major causes of congestion observed by the commuters include break down of vehicles (45%), lack of overhead bridges (45%), poor road network (44%) and poor drainage system (43%).

Nonetheless, these causes can be prevented by adequate provision of transport infrastructures, adherence to rules and regulations of town planning authority, proper enlightenment of the drivers on traffic education among others. However, long term policy approach is required to apprehend increase in personal vehicle ownership, large number of tax/bus, presence of heavy trucks and construction of overhead bridge/flyover.

Tab. 5 Effects of traffic congestion on the productivity and income of the commuters

Effects	%	Effects	%
Lateness to work	65.4	Health problems	15.6
Lateness to school	30.1	Accident	2.3
Miss appointments	16.4	Road rage	4.5
Tiredness	38.4	Pollution	24
Query at work	12	Additional transport fee	14.1
Fuel consumption	30.1	Increased inventory holding	1.5
Late delivery of logistic	6.1		

	Mean	Minimum	Maximum
Time wasted in congestion	8.68	2	20
Additional travel cost (\$)	0.18	0.05	0.5

Impact of traffic congestion on productivity	Yes= 82.4% No= 17.6%
Impacts of travel time variability	Less time for productive activities=55.45%, Inability to forecast travel time=32.73%, Late supply of goods and services=9.09%, Others= 2.7

Source: Computed by the Authors

Data in Table 5 show that lateness to work (65.4%), tiredness (38.4%), lateness to school (30.1%), fuel consumption (30.1%) and pollution (24%) were the major effects of congestion on commuters on the selected routes. It is obvious and not surprise that lateness to work topped the list of effects of congestion on the commuters which is in consonance with the findings of [23] that lateness to work and school due to congestion are the major losses incurred by respondents. Equally, tiredness, lateness to school, burning of more fuel than required and pollution are the other major effects commuters identified. For the first two effects mentioned, it is obvious that productivity on the part of workers is reduced as a result of time wasted on traveling and tiredness on reaching their work place while students most times miss classes which might lead to poor performance in their studies.

Each commuter spends 9 minutes on the average in congestion everyday which reduces their time for productive activities. This implies that about 59 hours for productive activities are lost to congestion every day by all the commuters who participated in the study which is a huge loss to the economy. It is argued that workers time wasted due to traffic congestion potentially cause productive sector a significant loss in productivity [21]. This reduction in productivity will also cause a significant reduction in the income of the commuters. The commuters who agreed paying additional money for transport fares because of traffic congestion normally pay an average of ₦69 (\$18). The additional money spent increases their cost of living. Almost all (82.40%) the commuters agreed that congestion has a negative impact on their productivities at work. Table 5 also reveal that less time for productive activities (55.45%) and inability to forecast travel time (32.73%) are the major impacts of travel time variability on the commuters. This will make the commuters to budget more time for travelling at the expense of working.

5 CONCLUSION AND RECOMMENDATIONS

The study examined economic implication of traffic congestion and travel time variability on some selected roads in Ilorin, Kwara State. The commuters along these roads experience traffic delay virtually every day, to and fro work in the morning and evening respectively at the peak hour. The routes feed Kwara State Polytechnic main campus, University of Ilorin Teaching Hospital Maternity Centre, University of Ilorin permanent site and an array of secondary and primary schools, Federal Secretariat, Ipata Market to mention but few. This has serious implication on productivities and income, as parts of their productive time would have been wasted in traffic delay. The findings show that majority of commuters interviewed are civil servants which fall within the productive and working age.

Also, the commuters experience 9 minutes traffic delay every working day; invariably, the commuters covered by this study waste 59 productive hours during daily traffic congestion. It further shows that commuters spend an average of ₦69 (\$0.18) as additional fare due to traffic congestion every day. The study shows that traffic congestion has a negative impact on the productivities of the commuters that travel along those routes. The study conclude that factors such as inadequate road capacity, illegal on-street parking, poor driving habit, encroachment on the right of way, too many taxis/buses, poor traffic control management are the major causes of congestion along these roads. The major effects of congestion on commuters on the selected routes are lateness to work, tiredness, lateness to school, fuel consumption and pollution.

Based on the findings of the study, the paper therefore recommends a strict implementation of rules and regulations through the town planning authorities with strict adherence to erections of retail stall. This will expand the road capacity and as well prevent building of structures on the right of way. Functional, fast, affordable and reliable mass transit which can convey a large number of people should be provided by the government or employers to replace large quantity of taxicab, as this will provide sustained relief on our roadways. If employers of labour can also provide accommodation close to their respective place of work, the negative effect of distance could be minimized. Government should impose financial penalty on the law disobeying drivers. It should be made to dissuade the drivers from certain congestion-causing habit such as illegal parking. Toll can as well be imposed on those roads to discourage less important trips. Furthermore, more access roads can be constructed.

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