T – Test Analysis of the Impacts of Traffic Congestion in the City Shillong

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Abstract: Shillong, the capital city of Meghalaya has been facing roadway congestion increasingly with rapid growth of population, socio-economic activities and vehicular movement giving rise to a number of negative externalities. The objective of the study was to find out the impacts of traffic congestion the private individuals, taxi drivers and businessmen. This study tried to examine to examine the impacts of traffic congestion on the number of trips made by the commuters, extra time spent due to traffic congestion, extra fuel expenditure and on the impact on Net profit. The results of the t-test in case of Private Car Owners, Taxi drivers cum owners and Businessmen are found to be significant at one per cent level of significance thereby rejecting the null hypotheses of no significant variation in those target variables due to variation in traffic congestion.

1. Introduction

Shillong, the capital city of Meghalaya has been facing roadway congestion increasingly with rapid growth of population, socio-economic activities and vehicular movement. Pressure on road has been increasing exponentially and the adverse impacts of congestion sometimes surpass the beneficial effects of transportation. In other words, there is a rapid increase in negative externalities in the form of severe traffic congestion due to increasing number of vehicles with limited road space.

Traffic Congestion continues to remain one of the major problems in most cities all over the world, especially the developing regions resulting in massive delays, monetary losses, fuel wastage, and accidents that sometimes cause death of human being and other lives (Kwikiriza, 2016). Traffic congestion has many negative impacts on the commuters like physical stress, effect on daily income, time loss, extra transportation costs, extra fuel costs, etc. (Mahmud et al, 2012, Achi, 2016). Ialam and Kalita (2017) stated that traffic congestion leads to noise pollution that further leads to deteriorating health conditions of the commuters. Apart from leading to negative economic impacts like increase in travel time, fuel cost, etc., congestion also leads to many environmental externalities like emission of fine particulate matter $PM_{2.5}$ which leads to premature mortality (Levy et al, 2010). Jereb et al (2017) also focused on the environmental impact of traffic congestion caused due to excessive emission of CO_2 and PM_{10} ($PM_{2.5}$ and PM_1). Increase in travel time required for trips, increase in Vehicle Operating Costs (VOC) and increase in volume of emissions from vehicles are three main principal effects of traffic congestion (Greenwood and Bennett, 1996).

Most of the studies have stressed on the environmental impacts of traffic congestion. An attempt has been made here to examine the impacts of traffic congestion on the number of trips made by the commuters, extra time spent due to traffic congestion, extra fuel expenditure and on the impact on Net profit.

2. **Review of Literature**

Studies Abroad

Externalities due to traffic congestion as mentioned by Lee *et al* (2008) were increase in travel time, air pollution and fuel consumption. It is also mentioned that traffic congestion lead to a fall in value of land in areas which were prone to severe traffic jam. Excessive inflow of vehicles, long queues and lack of parking places were identified as the reasons for congestion.

He (2012) identified various negative effects of traffic congestion as journey delays, time wasted, business loss, reduction in the quality of life, etc. He aimed to define Extension Traffic Simulation System (ETSS). The author discussed in traffic congestion in detail and cited examples of Dalian, China where ETSS was used to help them in road traffic management. He identified 5CW problems of traffic congestion to better understand road traffic management, like when happened, where, how, why and what change.

Ye (2012) identified the impacts of traffic congestion in China as longer travel time, increase in energy consumption, environmental pollution and traffic accidents. In order to estimate the price of traffic congestion, factors like vehicle types, congestion degree, road network situation and travellers bearing ability were considered. They opined that development of scientific plan, strong support of the public, development of public transport could be helpful in solving the problem of traffic congestion.

Thwala *et. al.* (2012) examined the causes and effects of traffic congestion in urban Nigeria. The most notable urban transport problem listed were traffic congestion and parking difficulties, longer commuting, environmental impacts, energy consumption and accidents. Using questionnaire data were collected from 150 sample respondents. Overall, the city residents spent almost double of normal time on their trip from home to office due to traffic congestion.

The indirect impacts of traffic congestion in Nairobi as identified by Chama (2013) include political and marginally on environment and resources, on the quality of life, stress, safety as well as on non-vehicular road space such as users of sidewalks and the road frontage properties. Harriet *et. al.* (2013) examined the extent to which traffic congestion negatively affects workers' productivity in Kumasi Metropolis, Ghana by using primary data collected from taxi drivers and mini-buses through questionnaire and sample units were selected through quota sampling technique. The result showed that the average number of trips by the drivers was less than the expected trips and hence it affected their earning

Khan and Islam (2013) analysed congestion impacts in terms of travel time costs, vehicle operating costs and externality costs due to delay and environmental damages. They tried to estimate the cost of traffic congestion in monetary terms through travel time cost and vehicle operating cost in Dhaka city, Bangladesh. Time spent on travelling has an opportunity cost which includes Total Time Variability loses (Rahane and Saharkar, 2014).

Wastage of time, delay in the movement of vehicles, wastage of fuel, increasing air pollution, wear and tear of vehicles, stress and frustrations of road users, perishing of agricultural products, etc. were identified as some of the effects of traffic congestions in Oyo, Nigeria (Raheem *et al*, 2015). Broadly the effects of traffic congestion were classified into health effects, environmental effects and economy effects.

Studies in India

With every increase in population and economic activity in Delhi, the travel demand increased manifolds (Singh and Sarkar, 2009). In the study, costs associated with roads were classified as private cost in terms of fuel loss, time loss, wear and tear of vehicles, etc. Commuting costs associated with traffic congestion were increasing noise, fumes, and dangers of accidents and loss of amenity. Here, two approaches - engineering and economic approach were considered by the authors for analysing traffic congestion costs. Through engineering approach time lost is measured by pricing time loss at average income levels, whereas through economic approach traffic level is determined as a function of the demand for road use. Major traffic flows were observed between 9 A.M. to 9 P.M. Average vehicular speed during peak and off peak hour varies between 10 to 35 Km/Hr.

Chakraborty and Gupta (2015) examined both the positive and negative externalities associated with traffic congestion. The study showed that in Kolkata total congestion ranges from 20 to 60 minutes per trip for an average commuter due to both recurrent and non-recurrent congestion. Peak hour's recurrent congestion was found from 6:00 A.M. to 9:00 A.M. in the morning and 3:00 P.M. to 7:00 P.M. in the afternoon. Costs associated with congestion include not only pecuniary but also of time losses, pollution, accidents, etc. Findings revealed that about Rs. 74077.66 were lost by a commuter only in two hours (during 9:00 A.M. - 10:00 A.M. and 6:00 P.M. - 7:00 P.M.) in a day and subsequently the monthly and annual costs or losses were estimated as Rs. 2222329.80 and Rs. 26667957.60.

Thus, negative impacts of traffic congestion include wastage of time, delay in reaching destination, increased fuel consumption, environmental pollution, and higher chance of collision. Major remedies include parking restrictions, change in social timing to reduce rush hours, introducing traffic counters, better traffic management, imposition of speed limit, lane splitting, provision of flyovers, construction of metro and public enlightening programs. Babitha and Jaseela (2016) analysed congestion based on queuing theory, which helped to calculate queue length formed in the lane. They calculated traffic flow with the help of the following formula, $F(t) = f(t) + fe(t) - fl(t)$. Where $F(t)$= flow in lane a-b, $f(t)$= sum of all flows to node a, $fe(t)$= flow entering lane and $fl(t)$= flow leaving the lane.

3. **Objective of the Study:**

The objective of the study is to find out the impacts of traffic congestion the private individuals, taxi drivers and businessmen.

4. **Hypotheses**:

a) There is significant impact of traffic congestion on the number of trips, time spent, fuel expenditure and net profit of the private individual commuters.

b) There is significant difference in number of trips, time spent, fuel expenditure and net profit of the taxi drivers[1] with changes in traffic congestion.

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[1] Though taxi drivers or owners cum drivers are also businessmen, but in this study, they are considered separately for the specific impacts of congestion on them, which is partly different from that of the general businessmen.

c) There is significant difference in number of trips, time spent, fuel expenditure and net profit of the businessmen with changing traffic congestion.

5. Data and Methodology:

Primary data have been collected through structured questionnaire on the number of trips made by the commuters, extra time spent due to traffic congestion, extra fuel expenditure and on the impact on Net profit on days of traffic jam and on days without traffic jam (during July 2019- September 2019). For the purpose of the study, 600 individuals were selected randomly in the city of which 200 were private individuals owning car and daily commuters, 200 taxi drivers and 200 businessmen.

Impacts of traffic congestion have been explained in relation to decline in number of commuting trips, extra travel time, and wastage of fuel and loss of net profit by using t-test. Results of impacts on private individuals, taxi drivers and businessmen have been presented separately.

6. Results and Findings :

Impact of Traffic Congestion on Number of Trips, Time Spent, Fuel Expenditure and Net Profit

An attempt has been made to test the significance of impacts of traffic congestion by using t-test with respect to indicators like extra time spent on traffic jam, increase in fuel expenditure and decline in productivity of the commuters (Private car owner, Taxi Drivers and Businessmen). Reduction in frequency of trips of the taxi drivers in Shillong city due to traffic jam is also approximated. Traffic congestion significantly affects drivers' productivity and adversely affects the economy (Eddington, (2006), May and Marsden, (2010), Hariet et al, (2013), Elisonguo, (2013) & Choi et al, (2013). The congestion not only affects the taxi drivers adversely but also the businessmen who have to suffer from significant opportunity costs for being unable to start or operate their businesses timely, attend meeting/ negotiations etc. It is found that opportunity costs of the taxi drivers are much higher as compared to that of the private individuals, as net profit or earning of a large section of private individuals, who are government servants, are least affected. Whereas, net earnings of the taxi drivers are immensely affected due to rising fuel expenditure and lesser number of trips possible on account of traffic jam and the extent of their loss in productivity is dependent on the intensity of traffic congestion.

Table 1: Test for Effects of Traffic Congestion on Number of Trips, Time Spent, Fuel Expenditure and Net Profit						
Private Car Owners						
Indicators	**Mean**	**Std. Deviation**	**Std. Error Mean**	**t**	**df**	**Sig. (2-tailed)**
Time Spent on Traff_jam_days-vs-less traffic_Day	-26.800	16.062	1.136	-23.597	199	.000
Net_profit_freeway- net_profit_jam	104.750	356.159	25.184	4.159	199	.000047
Fuel_exp_school_freeway-vs-fuel_exp_school_jam	-36.775	45.927	3.248	-11.324	199	.000
Fuel_exp_office_freeway-vs-fuel_exp_office_jam	-70.809	104.242	7.390	-9.591	199	.000
Fuel_exp_marketing_freeway-vs-fuel_exp_marketing_jam	-49.950	58.499	4.136	-12.075	199	.000
Taxi Drivers Cum Owners						
Within Trip_with_Traffic Congestion	-5.145	2.706	.191	-26.89	199	.000

and Trip_Without Traffic Congestion						
Within TimeLoss on less Congested day and Time Loss on severely Congested day	-16.895	11.194	.792	-21.34	199	.000
Within Fuel Expenditure on Less Traffic day and Fuel Expenditure on Severely Congested day	-188.00	105.768	7.479	-25.14	199	.000
Within Net Profit on Less Congested Days and Net Profit on More Congested Days	281.75	233.887	16.538	17.04	199	.000
Businessmen						
Time_Watage_on_less_traffic_day - vs- Time_Wastage_on_congested_day	-38.275	15.430	1.091	-35.080	199	.000
net_profit_freeway–vs- net_profit_jam	704.500	544.068	38.471	18.312	199	.000
Fuel_exp_school_freeway –vs– fuel_exp_school_jam	-38.950	32.145	2.273	-17.136	199	.000
Fuel_exp_office_freeway- vs fuel_exp_office_jam	-49.075	48.128	3.403	-14.420	199	.000
Source: Calculated by the author using the primary data collected.						

The hypothesis that has been tested is whether there is significant difference in time spent, number of trips, fuel expenditure and net profit of the commuters in the city due to variation in traffic congestion. The results in case of Private Car Owners, Taxi drivers cum owners and Businessmen are presented in Table 1. Here, the t values are found to be significant at one per cent level of significance and thereby rejecting the null hypotheses of no significant variation in those target variables due to variation in traffic congestion.

It is thus evident from Table 1 that there is significant reduction in the number of trips, increase in travel time for identical distance, rise in fuel expenditure and reduction in the net profit of the taxi drivers when compared those values of the days of traffic jam with those of the days without traffic jam.

One of the direct impacts of traffic congestion is time loss. Respondents have revealed that traffic congestion significantly increase their travel time to reach destination. They have revealed that most of the time they are not able to forecast their travel time due to severe congestion. It is revealed that even for few Kilometres distance to travel; they have to start from home early because of the fear of being stuck in traffic jam. It has been recorded that especially during exam days, the respondents have to start from home at least one hour or two, in order to reach their examination hall in time. The problem of being stuck in traffic jam especially during examination is more severely faced by those students, who are not staying in Shillong and have to come daily for their education to the city. There are many students from outskirts of the city, who daily come for their school, college and university for studies. They have revealed that during personal interview traffic congestion have drastic negative impacts on their performances, as it affected their mental state badly. They have further expressed that many a times they have to miss their regular classes due to traffic congestion. There are many students coming from places nearby locations like Mawiong, Barapani, Umsaw, Umsing, etc. revealed that they have to spend lots of time in excess of normal time in travelling daily for their education.

Fuel wastage due to traffic congestion is another direct impact of it. Respondents have revealed that costs on fuel increased along with the increase in intensity of traffic jam. Even for travelling small distance

within the city, they face traffic jam. Respondents revealed that fuel consumption is more especially due to school duty and for marketing purposes.

Traffic congestion has significant negative impact on the net profit of the respondents (Table 1). The taxi drivers particularly have revealed that there is significant reduction in the number of trips made by them in a day due to traffic congestion. This further affects their daily income as their earnings are heavily dependent on the number of trips that they can make. Traffic congestion therefore adversely affects their performance and has a negative impact on the economy.

Traffic congestion further has a negative impact on the business activities in the city as well (Table 1). Business activities are greatly affected due to this. Starting business activities on time is very important for its healthy performance for the businessmen. Many of the businessmen have revealed that they are unable to start their business on time due to traffic congestion. As a result of this, it has a negative impact on their profits. Therefore, to reduce its impacts in future, strict measures should be undertaken to check the problem of traffic jam in the city.

7. **Conclusion**:

In this paper an attempt has been made to test whether traffic congestion has an impact on number of trips made by the commuters, extra time spent due to traffic congestion, extra fuel expenditure and on the impact on Net profit. The following results have been found:

➢ *Hypothesis 1:* There is significant impact of traffic congestion on time spent, fuel expenditure and net profit of the private individual commuters.

This hypothesis has been accepted in respect of all chosen variables, since the results of t-test showed that there has been significant increase in travel time, reduction in the net profit and increase fuel expenditure to office, school and marketing among the private individuals due to traffic congestion.

➢ *Hypothesis 5:* There is significant difference in number of trips, time spent, fuel expenditure and net profit of the taxi drivers with changes in traffic congestion.

This hypothesis has been proved since results showed that there is significant reduction in the number of trips, increase in time loss, extra fuel expenditure and lower net profits of the taxi drivers due to traffic congestion.

➢ *Hypothesis 6:* There is significant difference in time spent, fuel expenditure and net profit of the businessmen with changing traffic congestion.

This hypothesis has also been proved since results of the t–tests showed that there is significant increase in time loss, extra fuel expenditure and lower net profits of the businessmen due to traffic congestion.

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