International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 5 Issue 4, April-2016

A Comprehensive Study on Highway Expansion and Traffic Congestion in India

Puneet Sahni[1], Dr. V. K. Ahuja[2]

[1]M.Tech Student, Civil Engineering Department, Baba Mast Nath University, Rohtak, Haryana
[2]Head of Department (Civil Engineering), Baba Mast Nath University, Rohtak, Haryana

ABSTRACT

Traffic congestion is a significant time cost for many urban commuters. This paper studies the impact of highway expansion and traffic congestion including direct route that becomes increasingly congested as more people travel on it and more indirect route that does not become congested. More specifically, the author studied three different toll implementations.

Paying the toll can reduce waiting times. There is substantial heterogeneity in outcomes between groups, which is likely due to the distribution of values of time by session. This may help explain why similar traffic networks have different commuting patterns when they serve different populations. The second toll design imposes monetized heterogeneous time costs. As the level of heterogeneity rises, the number of travelers on each route becomes more stable. This contrasts with other experimental work, which shows a substantial level of instability in a homogeneous framework. Finally, I also analyze various models to study behavior in a no-toll homogeneous framework. While no theory explains individual behavior well, the author found that some theories explain aggregate behavior quite well.

I. INTRODUCTION

The role of transportation in human life cannot be over emphasized. Efficient transportation system plays an important role in catering to the daily necessities in the lives of the citizens. These include access to amenities and services that are central to the lives of all individuals, like employment, education, health services and leisure. At the individual level, Wane (2001) also points out that 'transportation is a crucial vector for urban insertion since it gives access to economic activity, facilitates family life and helps in spinning social networks. It links the different spaces of the city on which an individual or a family has to implement his or its tri-dimensional strategy of life (i.e. family, work, residence). So, urban mobility is at the heart of the challenges faced by any city dweller'. Consequently, cities in the world have witnessed tremendous motorization during the recent century, especially since 1988 global car population exceeded 400 million.

The reason for this phenomenon, according to Dimitriou (1991) is that in both the Developed and Third World countries, few activities are more poorly managed than urban transport. As such, the failure of public transport to meet the needs of travelers has intensified the demand for private cars. A leading think tank in the UK, The Optimum Population Trust papered that in the year 2000, about one in nine of the world's 6.1 billion people owned a car or van. For the same year, the Mobility 2030 paper, issued by the World Business Council for Sustainable Development (2004), suggests that there were nearly 700 million light-duty vehicles (LDVs) i.e. automobiles, light trucks, and derivatives such as sport utility vehicles and minivans in cities of the world. The LDV numbers, according to the paper, are said to be growing at 2 % annually until it reaches about 1.3 billion by 2030 and to just over 2 billion by 2050.

Interestingly, it is said that nearly all of these increases will be in cities of the Developing World due to expanding economic growth (ibid). Owing to this high level of motorization, combined with inadequate traffic management strategies, an aging and ill maintained vehicle stock, as well as inadequate land use and transportation planning, especially in the Developing Economies, modern-day cities have witnessed very significant proportion of traffic congestion. Described as a phenomenon of increased disruption of traffic movement on an element of the transport system, traffic congestion is most visible when the level of demand for movement approaches or exceeds the present capacity of the element (Taylor, 1999). As Taylor et al. (2000) argue, traffic congestion presents a common, if not inevitable, facet of traffic activity in a region, particularly in urban areas.

It is interesting to note that even though traffic congestion is such a critical problem in some major urban areas of the world, Palma & Lindsey (2002) are of the opinion that it is not a recent phenomenon at all. It is said that the 'problems of traffic congestion in urban areas were prevalent during the 18th and 19th centuries and also during the heyday of the Roman Empire. Indeed, chariot riding was banned in Rome during peak hours because of traffic jams. However, the current prevalence of congestion in surface travel has been exacerbated by sheer volume of the automobile and other motorized forms of transportation on the roads. The situation is further aggravated by the human population explosion, especially at the urban centers.

II. TRAFFIC CONGESTION

In Indian Conference of Ministers of Transport's opinion (2004), traffic congestion is a situation in which demand for road space exceeds supply. Congestion is the impedance vehicles impose on each other, due to the speed-flow relationship, when the use of a transport system approaches capacity. It is hard to say what is traffic congestion exactly, since there is no standard of traffic congestion worldwide and traffic system varies from one city to another. Downs (2003) has the notion that the traffic on any given artery can be considered congested when it is moving at speeds below the artery's designed capacity because drivers are unable to go faster. If there is a street designed 50 miles per hour, and most of vehicles' speeds on this street are lower than 50miles per hour, there is traffic congestion. So in Downs' opinion, traffic congestion is closely related with designed standard.. Generally speaking, it could be defined as vehicles blocked on the street and their average speed lower than one level or people spend much more time on the road which is unendurable.

Causes of traffic congestion

Before the middle of the nineteenth century, all cities in the world were designed or developed on the base of walking. From the time of 1860s, many cities' structures were changed in the force of Industrialization. Narrow streets were collapsed and replaced by wider roads which are suitable for car. But with more and more cars appearing on the streets, traffic congestion became a problem in many cities in the world since 1945. The use of vehicles plays an important role in the history of cities' economic development. Since vehicles make people's moving more conveniently, powerfully, flexibly and efficiently, people want to have their own cars when they get enough incomes. There is a strong correlation between the GNP per capita and the number of vehicles in a country. Based on that it can be predicted that when residents' income in countries like China in the southwest of the picture get closer to countries like US and Japan in the northeast of the picture, the number of vehicles will increase.

The Cost of Traffic Congestion

When considering the cost of a problem such as traffic congestion, it is important to differentiate between costs borne by individuals and businesses, and the costs borne by society as a whole. For example, time lost to slower than normal travel speeds or the extra fuel consumed by idling in traffic are costs borne by the individual, whereas increased air pollution and greenhouse gas (GHG) emissions, as a result of congested roadways, are costs borne by society. Therefore, to capture the full cost of traffic congestion, both the cost to individuals and businesses (private cost), and the cost to society (social cost) must be combined. In other words, the total cost is equal to the sum of all private costs, plus all social costs, as represented below.

Private Cost

When a roadway reaches its congestion point (the maximum capacity of the roadway), normal, uncongested, free-flow speeds quickly turn to slower, congested, restricted-flow speeds. Each additional vehicle entering a congested roadway exacerbates this effect, and can eventually bringing the flow of traffic to a halt. The resulting private cost of this congestion is truly staggering. According to Shrank et al. (2011), in 2010, traffic congestion resulted in 4.8 billion hours of delay and 1.9 billion gallons in wasted fuel. Adding together the cost of delay and wasted fuel, Shrank et al. estimated traffic congestion cost $101 billion. Dividing this figure on a per commuter basis, the authors calculated that traffic congestion cost the average commuter $713 in 2010 alone.

To put this amount in perspective, per capita state and local taxes paid in 2009 equaled $4160 (Tax Foundation, 2012). In other words, traffic congestion in 2010 was akin to a 17% increase in the tax burden for commuters. While Shrank et al. (2011) calculated the private cost of traffic congestion to individuals, their papered amount does not account for the private cost to businesses. Traffic congestion poses a cost to businesses in two primary ways. First, it delays the movement of goods, reducing productive efficiency, particularly for "just-in-time" manufacturing operations and businesses that rely on frequent deliveries of goods to provide services (Downs, 2004; O'Toole, 2009). Second, it creates travel time unreliability, therefore increasing shipping costs and creating distortionary effects to the market as people and businesses struggle to make optimally efficient decisions based on this uncertainty (Downs, 2004; O'Toole, 2009).

Winston and Shirley (2004) argued that it can be difficult to quantify these costs; however, they developed a model to approximate the cost of congestion on shipping. According to the authors, the cost traffic congestion on shipping is equal to the daily discount rate on the value of the good being shipped,2 multiplied by the total value of the shipment, multiplied by the time the shipment is delayed (in days or fraction of days). Based on this model, Winston and Shirley estimated that increased shipping costs equal approximately 25% of the papered cost of traffic congestion.

III. TRAFFIC CONGESTION IN INDIA

This author believes that the factors that led to the collapse of the express bus service on the Delhi-Jaipur highway represent a microcosm of the overall factors that affect public transport provision in general in India. As such, a discussion on the broader context within which the pilot BRTS operated before its demise will be most ideal. This chapter, therefore, takes a look at the public transport system as well as the phenomenon of traffic congestion in the city of India. Sub-themes that will be considered include an overview of the regulatory framework for public transport, the road network and the types of public transport services provided in the city. Also, the incidence and the causes of traffic congestion are discussed as well.

The Road Network of India

The road network in and around the city of India is based on a system of radial routes converging on the Central Business District. A major weakness in the network, as identified by these authors, is the lack of adequate east-west corridors. It is said that the lack of a good road system causes a country's 'wheels of development [to be] mired in mud'. As such, the relevant government authority is undertaking infrastructural developments in the transport sector with the hope that this identified weakness may be resolved in the near future. The Department of Urban Roads notes for instance, that the designs for 106 km of arterial roads, 60 km of local roads and 3 Interchanges have been completed for the India East corridor and the first 2.7 km of the proposed 15 km main arterial link to the west of India has been built already. Presently, however, there are only four radials, three of which are heavily used and experience considerable traffic congestion. Following extensive studies on these arteries, Segbefia notes that flows of vehicles per minute ranged from 10 to 14 in morning peak hours and 8 to 12 in evening peak hours.

Causes of Traffic Congestion in India Traffic congestion all over the world is a function of human activity. At a one-day conference on 'Traffic Congestion in Major Urban Cities in India' held on February 2013 by the seasoned engineers from all over the country took turns to address the problem of traffic congestion. Some of their views , are presented and discussed. Moreover, inefficient use of the existing road capacity has been identified as a third and major contributory cause of traffic congestion (ibid). In this chapter, I have already discussed the nature of India's urban transport system. As such, that will not be the focus of further discussion but one obvious characteristic of the system that needs to be mentioned again is the over-reliance on the use of low carrying-capacity trotro vehicles. Available figures indicate that in 2004, 1.3 million passengers commuted the Central Business District of India on a daily basis. Out of this figure, 1 million used trotro or taxi. By 2024, an estimated 3.04 million passenger trips/day will enter or leave the CBD (GhIE, 2013). While majority of the trotros are old and badly maintained, their carrying capacities are between 12- 15 and 22-33 passengers. The legal carrying capacity for taxis is 4 passengers. According to Kwablah (2013), whereas trotros and taxis carry 52 % and 9 % respectively of the travelling public, they use 27 % and 18 % road space. Another mode of transport which carries few people i.e. 13 % but uses maximum road space (33 %) is private cars. The rest of the statistics are presented in Figures 1 and 2.

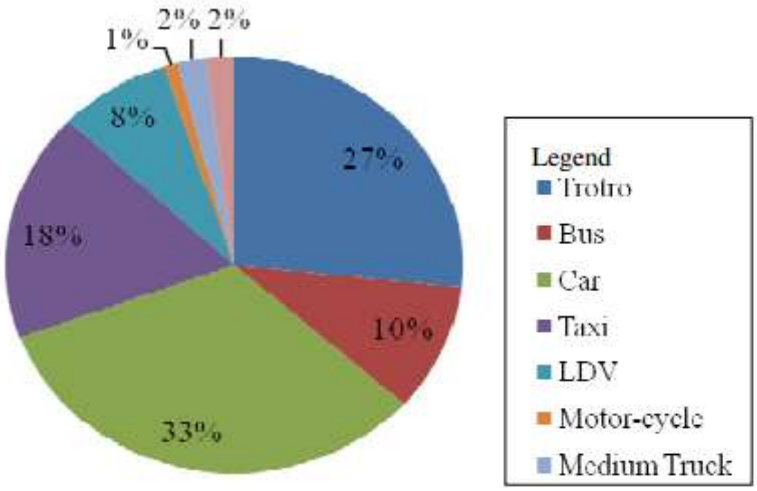

Figure 1: Percentages of Road space Usage per Transport Mode in India

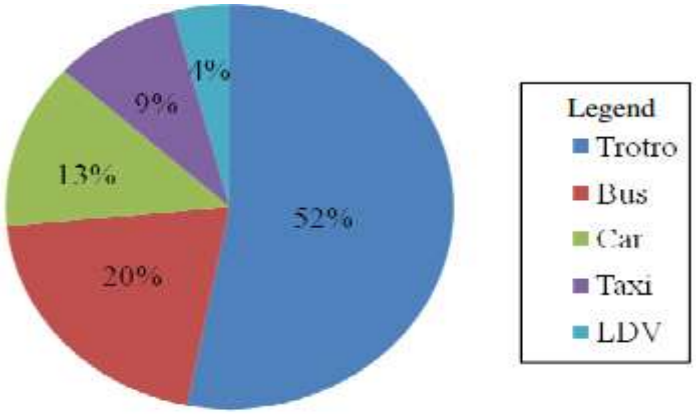

Figure 2: Percentages of Passengers Carried per Transport Mode in India

The land use and traffic nexus as observed in India could also account for the endemic traffic congestion in the city. The attainment of a vibrant and comfortable city life is a function of land use, transport, cultural values and the imagination and management skills of city officials. However, owing largely to the unplanned nature of Indian cities, of which India is no exception, coupled with weak local governance and an urban economy which is primarily trading-oriented, the various land use types such as residential, commercial, industrial, recreational, educational, sanitary etc are haphazardly developed Figure 3 and 4. The plates below, illustrate some of the land use and traffic patterns which either cause or perpetuate the incidence of traffic congestion in India.

Figure 3: Transport terminal on road shoulder

Figure 4: Commerce competes for space with vehicles

The over-concentration of economic activities in India, especially at the Central Business District is symptomatic of planning failure. Also, Tema's failure as a twin city with no viable central business and magnetic commercial centre has worsened traffic congestion in India. The spontaneity with which passenger terminals develop and their ubiquitous distribution in wrong locations also generate avoidable traffic.

The poor development, location and management of passenger terminals and transit points along the Delhi-Jaipur corridor constitute another land use practice that has either created or perpetuated traffic congestion. These terminals defy planning and architectural principles. They spring up spontaneously due to lack of discipline and strict compliance with laid down planning principles as contained in the master development plan of India. Most often, residential areas are developed without any consideration of public transport terminals. It is not uncommon to identify terminals that are built either near streets or on privately owned land, which inhibits the development of permanent structures.

Usually, it takes only one or two drivers to initiate such illegal acts. Within an overnight, others take advantage of the situation and join. With the setting up of such 'terminals' and the attraction of passengers, economic activities, usually informal trading such as food joints, mobile phone business transactions locally referred to as space-to-space as well as other traders who hawk all kinds of goods and services mushroom up. The situation then becomes the norm and the law enforcement agencies find it too late to intervene. In addition to other undesirable consequences of these illegal acts, severe but highly avoidable traffic congestion occurs. The author's personal observations are captured in Figure 5 below.

Figure 5: Land Use practises at a Junction.

Vehicles marked **'A'** and **'B'** are driving on the main corridor while **'C'** is entering a lorry terminal (out of view) which is located close to the main corridor. The area marked **'D'** represents pedestrian walkway that had been invaded on by traders (with umbrellas for shade against the sun) and advertisements and sign posts. This invasion of the walkway consequently forces pedestrians into the main corridor which usually results in traffic accidents or causes traffic congestion as drivers have to slow down to avoid knocking down pedestrians. The vehicle marked **'E'** is a trotro that has been parked on the shoulders of the road for passengers to disembark and also to allow other passengers to embark until it is full to capacity. As soon as that is achieved, and without warning, the driver of the trotro will quickly force its way into the main corridor again, as represented by the taxi marked 'F'. The vehicles marked 'A' and 'B' which are on the main highway could either crush into vehicle **'F'** , which is usually the case, or slow down and cope, thereby prolonging the travel times on this segment of the road. A similar situation is observed at segment 5 i.e. from the License Office to the 37 Military Hospital areas.

CONCLUSION

With the use of the former pilot Bus Rapid Transit System (BRTS) on the Delhi- Jaipur Highway as a case study, this review sought to identify the causes of traffic congestion on the said corridor; to explore the extent to which traffic congestion was the nemesis of the pilot project, as well as identifying other possible factors that might have jointly contributed to collapse the express service. Information obtained from a review of current literature on the subject, the Time-Geographic framework as well as the Structuration and General System's theories respectively were used as keys to unlock and interpret the study. Concerning the methodology, both primary and secondary sources of generating data were used. In relation to the primary data, the triangulation approach (i.e. quantitative and qualitative methods) was adopted even though maximum weight was given to former over the latter. GIS-based techniques such as the GPS, the stopwatch and a computer readable traffic congestion registration form were the main tools used in deriving the quantitative data. The research tools used in generating the qualitative data were: in-depth interviews with five key informants; semi-structured interviews with three MMT drivers; a focus group discussion with three MMT passengers and personal observation. Secondary sources of data were obtained from books and journals, in the libraries and on the internet, census data and newsletters of the MMT. The study also explored some characteristics of the study area and the general nature of traffic congestion and public transport delivery in the city of India.

REFERENCES

[1]. Guohua, Z., Ming, LI., & Jingxia W. (2007) Journal of Transportation Systems Engineering & Information Technology Volume 7, Issue 5, October 2007.
[2]. Hagget, P. (1965). Locational Analysis in Human Geography. London: Edward Arnold. In Johnston, R.J., Gregory, D., Pratt, G. & Watts, M. (Eds.). (2000). The Dictionary of Human Geography (4th ed.), Blackwell.
[3]. The India Urban Transport Project (2008). 'Brochure for Public Forum'. Ministry of Transportation.
[4]. Walsh, M. (1990) Global Trends in Motor Vehicle use and Emissions. In Annual Review of Energy, Volume 15, pp. 217-243.
[5]. Gibbs, W.W. (1997) Transportation's perennial problems. In Scientific American , Volume 277 pp. 54–57.
[6]. Dynarski, Susan, "Who Benefits from the Education Saving Incentives? Income, Educational Expectations and the Value of the 529 and Coverdell," National Tax Journal, June 2004, 57, 359-383.
[7]. Ehrenberg, Ronald G., and Daniel R. Sherman, "Employment While in College, Academic Achievement, and Postcollege Outcomes: A Summary of the Results," Journal of Human Resources, Winter 1987, 22, 1-23.
[8]. Fischbacher, Urs, "z-Tree: Zurich Toolbox for Ready-made Economic Experiments," forthcoming Experimental Economics.
[9]. Müller, Wieland, and Andrew Schotter, "Workaholics and Drop Outs in Optimal Organizations," mimeo, January 2007.
[10]. Ochs, Jack, "Coordination Problems," in The Handbook of Experimental Economics, edited by John H. Kagel and Alvin E. Roth, 1995.
[11]. Viswanadham B.V.S., Das Arghya, Jayashree Ch., (2009) "Effect of randomly distributed geofibers on the piping behaviour of embankments constructed with fly ash as a fill material" Geotextiles and Geomembranes 27 (2009) 341–349.
[12]. Kaniraj, S.R and Gayathri V. (2003). Geotechnical behavior of flyash mixed with randomly oriented fiber inclusions, Geotextiles and Geomembranes, 21, 123-149.
[13]. BCA Specification for Stone Mastic Asphalt, BCA 9808, New Zealand Pavement & Bitumen Contractors' Association, August, 1-10, (1999).
[14]. Qadir A, Imam M., "Use of recycled plastic waste aggregate as a partial substitution material in pavement structure". In: Proceedings of the International Symposium on Pavement Recycling; 2005.
[15]. P K Jain, Shanta Kumar & J B Sengupta, "Mitigation of rutting in bituminous roads by use of waste polymeric packaging materials" Indian Journal of Engineering & Materials Sciences Vol. 18, June 2011, pp. 233-238
[16]. R Vasudevan., Nigam S.K., Velkennedy R., Ramalinga Chandra Sekar A.,Sundarakannan B. "Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers", International Conference on Sustainable Solid Waste Management, 5 - 7, Chennai, India pp-105-111, 2007.