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Review Paper "Congestion Pricing: A Solution To Traffic Congestion In India"

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Abstract

This paper reviews literature on the relationship between congestion and economics and shows how traffic congestion affects the economy of country and explained in the form of marginal cost and average cost. This paper emphasis on the congestion pricing as a solution to the problem of congestion to the places where land width is limited and the like central business district which are constructed long back and have no space for further enlargement of road width. This paper shows how congestion pricing reduce the demand without increment of system capacity. The paper also explains various types of congestion pricing schemes and methods of collecting charges are also explained in detail.

1. Introduction

Traffic congestion is a road condition characterized by high volume of traffic, slower speeds and longer trip times coupled with increased queuing of vehicles. It is the inconvenience caused due to overutilization of road capacity and increased costs that vehicle impose on each other while using their vehicles. The number of trips on highways and urban network is increasing continuously all over the world wide. To tackle this problem of traffic growth the mechanism of providing additional roads and widening the roads is used. But this solution in turn is just increasing the congestion on the roads. As there is limited land available to widen roads or to provide new road or flyovers but traffic is growing significantly causing economic, social and environmental losses. Congestion pricing is a technique currently in use worldwide.

Congestion pricing or congestion cost is a system of surcharging users of a transport network in period of peak demand to reduce traffic congestion. It is also known as road user charging or road pricing. Congestion Pricing aims to reduce rush-hour traffic by shifting it to other transportation modes (like carpools, vanpools and transit) or to off-peak periods. The various ways of road users charging are:-

1- Cordon based congestion charges
2- Distance based road users charges
3- Time of day charging

Generally to tackle the problem of congestion we have only two alternatives, either we meet the demand or we reduce the demand. Traditionally former method is used to solve the problem but due to the limited resources this method is now also not fulfilling the requirements. So the engineers have to alter the demand to fit the system capacity.

2. Literature

2.1Congestion and Economics

To understand how traffic congestion is related to transport economics it is necessary to understand both the terms traffic engineering and transport economics.

The speed slow relationship says that as flow increases speed decreases. An addition of one vehicle in the link increases the average cost and the marginal cost.

The Average cost is the cost of using the road and the marginal cost is the cost incurred by a reduction in speed due to the other vehicles on the road. It is this marginal cost which it is deemed necessary to add to drivers in the form of a congestion charge.

Considering, average cost curve which shows the sum of VOC and road cost for a journey at different traffic volume. Now suppose flow increases, then, speed start declining and cost start rising. Combining both the curves and placing them in equilibrium, it has been found that at point J, demand and supply are equal and cost of using road is equal to benefits of using that road as shown in fig-1.

Three variables are represented. First, the average cost curve shows the sum of the avoidable vehicle operating and road costs, for a journey, at different volumes of traffic, i.e., vehicle flows. As the flow increases, after a certain point speed declines and costs rise (At some extreme point there is a maximum possible flow and it is believed that, if

the number of vehicles trying to use the road exceeds this maximum, it can lead to an actual flow less than the maximum. Hence the cost curve will turn back at this point. But this is irrelevant to the argument.)

Road users pay their own operating costs, which for the sake of simplicity are assumed to be equal for all vehicles, and we shall now also assume that they pay their part of road costs through fuel tax. Then, if no additional charge is made, the price of a journey which each vehicle has to pay is the sum of its own operating costs and its contribution to road costs, i.e., the average cost.

As the price rises, the number of vehicles that will make the journey declines and this is represented by the demand curve (Fig-2). The position of equilibrium is indicated at the point of intersection B, between the demand curve and the average cost curve, where the flow is Q.

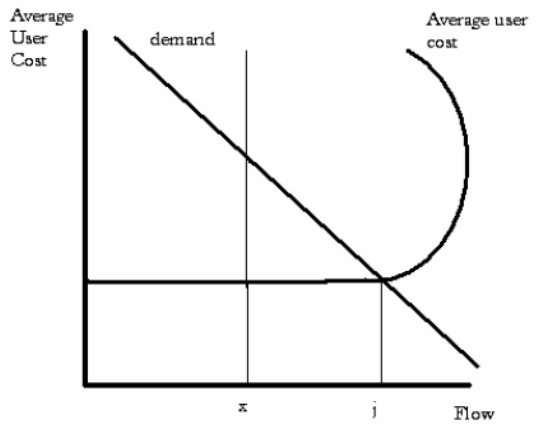

Fig-1: User cost and flow curve

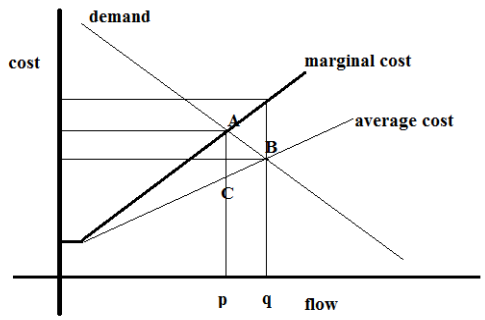

Fig-2: Flow cost curve

The third curve, the marginal cost curve, shows the marginal cost at different levels of flow, i.e., the increase in total costs caused by the addition of each extra vehicle. It is evident that, as the flow increases, each extra vehicle adds more to the total cost than it pays and, when the flow exceeds p, there are some vehicles which are not willing to pay the costs they cause. If a charge CA reduces the flow of traffic from q to p, where the demand curve intersects the marginal cost curve, journeys will not be made unless they are valued at more than the cost they cause.

2.2 Methods of congestion pricing

Congestion Pricing refers to variable road tolls (higher prices under congested conditions and lower prices at less congested times and locations) intended to reduce peak-period traffic volumes to optimal levels. Tolls can vary based on a fixed schedule, or they can be dynamic, meaning that rates change depending on the level of congestion that exists at a particular time.

2.2.1 Cordon pricing

Cordon pricing are the fees paid by the motorist to drive in a particular area, such as city centre (central business district). In this method of pricing city centre is encircled into different cordon lines by considering congested area. Then fees are collected from coming to that area at each entrance via toll booths or special permit passes.

2.2.2 Vehicle Use Fees/ Distance-based charges

Distance-based charges such as mileage fees can be used to fund roadways or reduce traffic impacts, including congestion, pollution and accident risk.

This is a proposal which is currently under review in the UK for a nationwide distance-based road user charging.

2.2.3 Road Space Rationing

A variation of road pricing is to ration peak period vehicle-trips or vehicle-miles using a revenue-neutral credit-based system. For example, each resident in a region could receive credits for 100 peak-period vehicle-miles each or Rs. 1200 worth of congestion fees each month. Residents can use the credits themselves, or trade or sell them to somebody else. The result is a form of congestion pricing in which the benefits are captured by residents rather than road owners or governments.

2.2.4 HOT Lanes

High Occupancy Toll (HOT) lanes are high occupancy vehicle (HOV) lanes that also allow use by a limited number of low occupancy vehicles if they pay a toll. This allows more vehicles to use HOV lanes while maintaining an incentive for mode shifting, and raises revenue. HOT lanes are often proposed as a compromise between HOV lanes and Road Pricing.

2.2.5 Regional pricing

It refers to policies in which people are charged to travel on a network of similar roads (for example highways). Unlike facility pricing, network pricing levies fees on several roads going in various directions. This fee structure is considered more accurate than facility pricing because more of the trip is included within the boundary of the system. Fees may be collected from a series of toll booths along the network or from entrance and exit ramps on controlled access facilities.

2.2.6 Facility pricing

Facility pricing is a mechanism in which pricing measure is levied on one or several roads that link residential areas to commercial areas (central areas). Fees may be imposed on new or existing roads; it is usually more acceptable on new facilities because it would then not be viewed as taking away a free service. For example, charging higher fees during peak hours encourage the people to car pooling or switch over to other public transport modes of transportation.

2.3 Methods of collecting fees

At present following methods are in use: -

1-Manual collection of the point charge at the entry point into (or out of) the area, or use of a coin-operated barrier (e.g. Durham, UK; Trondheim, Norway).

2-Decrementing smart-card – this communicates with roadside equipment and a charge is deducted from the smart-card when the vehicle passes a charging point, enters a charged area, or when its speed falls below a certain level (e.g. Singapore (charging point); as proposed in Cambridge).

3- Once payment has been received, registration of the vehicle details on a database. When enforcement equipment recognizes the vehicle, it is registered on the system as having paid, and no further action is taken (e.g. London).

4-Electronic tagging of the vehicle and the dispatch of a monthly bill to the owner depending on the number of times the vehicle has passed a charging point/entered a charged zone that month (e.g. Stavanger, Norway).

2.4 Benefits of Pricing Congestion

Following are the benefits of Congestion Pricing:-

1- Congestion relief by increasing vehicle speed and reducing peak period demand.
2- Reducing travel time
3- Making people to use public transport instead of private vehicle.
4- Environmental protection and road safety.

Benefits depend upon some factors such as:-

1- Type of pricing
2- Its way of implementation
3- Condition of transportation
4- Socio- economic level of road users

3. National and international experiences of application of congestion pricing

3.1International experiences:-

1. Singapore

Singapore was the first city to introduce road user charging back in 1975. Initially the system was paper based but in 1998 advanced ITS technologies were used to apply the system.

The charging system is a variable charge which varies from $0.5 to $3.50 per vehicle. This charge varies according to congestion rates, so in times of heavy congestion the charges are higher.

Singapore opted the Area license scheme (ALS) and after success of this they switch towards Electronic road pricing (EPR) system in 1995. The result was immediate reduction of 73 percent in the use of private cars and 30 percent increase in carpools, and a doubling of buses, share of work traffic.

2. London

They implemented the cordon pricing scheme and resulted in decrease in traffic entering pricing zone by 21 percent and about 43 percent increase in use of cycle and buses. In comparison with 2002 conditions, congestion in 2006 was 8 per cent lower.

3. Stockholm, Sweden

In 2006 a congestion charging trial was launched. The goals of this trial were as follows:

-Reduce traffic volumes by 10-15% on the most congested roads

-Increase the average speed

-Reduce emissions of pollutants harmful to human health and of carbon dioxide

-Improve the urban environment as perceived by Stockholm residents.

4. Trondheim, Norway

They implemented cordon pricing method and found 10 percent reduction in traffic at peak times and 8 percent increase in traffic in off peak times in the central business district.

5. USA

The first congestion pricing projectin the Unites States was implemented on California State Route-91 and serves as an example of a single facility project. The project covers a 10-mile stretch of road that links Riverside County suburbs to business centers in downtown Los Angeles. The facility was built as a two-way, where four-lane HOV road was designed in the median of an existing freeway.

3.2 National experience

A study was undertaken to examine the application of congestion pricing concept in Indian conditions

in Connaught place, New Delhi. Connaught place is the central business district and receives heavy volume of traffic throughout the day due to its strategic location. Cost of congestion was evaluated by traffic surveys and they are analyzed on the basis of quantification of external cost and estimation of reduction in traffic. They analyzed data on the basis of willingness to pay survey and suggested to use electronic road pricing technique.
Still, in India this technique has not been in use but work on this policy has been in progress.

4. Present scenario of Congestion Pricing in India: -

The detailed literature behind congestion pricing has been studied and its experiences have also been analyzed. It is found that there is a need of congestion pricing in India also. Considering Indian conditions, the current land width is less and day by day number of private car users are increasing significantly. Indian Central business areas are old and constructed long back and no space is available for any further growth. People are choosing their own mode of travel instead of public transport which is causing congestion and increase in demand. This increased demand causing congestion can either be meet by increasing system capacity, but due to lack of availability of land width this solution to the problem is not effective. So, the only way is to reduce demand by charging them for that facility. Electronic road pricing is best technique to collect revenue from road users. Congestion pricing can potentially reduce congestion by providing incentives for drivers to shift trips to off-peak periods, use less congested routes, or use alternative modes, thereby spreading out demand for available transportation infrastructure. Congestion pricing also has the potential to create other benefits, such as generating revenue to help fund transportation investment.

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