CONGESTION TAX VS DEVELOPMENT OF MASS TRANSPORT NETWORK FOR CONTROLLING CONGESTION IN KOLKATA

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Abstract

The rising world population and consequent growth in the population of developing nation necessitate the development of a comprehensive urban transport network .India is no exception. Especially in the case of Kolkata the growth in the number of vehicles, diversified modes of transport coupled with the problem of narrow road space contribute towards traffic snarls during peak hours. Congestion tax may be a very suitable policy option but may not be practically feasible in the context of Kolkata. Whilst the congestion tax is the most effective, imposing differential congestion taxes based on area and time of day, would be difficult to implement. There is an urgent need for other policy options to be substituted or to be used along with congestion tax for tackling congestion in Kolkata.

Introduction

The rise in world population is accompanied by significantly high growth rate (1.8% per cent) of urban residents. In the developing countries, urban populations are growing at the rate of 2.2 percent. The urban population in 2014 accounted for 54% of the total global population, up from 34% in 1960, and continues to grow. The urban population growth, in absolute numbers, is concentrated in the less developed regions of the world. It is estimated that by 2017, even in less developed countries, a majority of people will be living in urban areas. The global urban population is expected to grow approximately 1.84% per year between 2015 and 2020, 1.63% per year between 2020 and 2025, and 1.44% per year between 2025 and 2030(http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en).In India these percentages are slightly less than the average for developing countries (UNDP, 2005). Along with growing urban populace India's population (presently at 1.2 billion) is growing at the rate of 1.46 per cent (U.N, 2011). To meet this growing demographic pressure Indian towns and cities will require high investments on infrastructural facilities.

Kolkata, located in the eastern India, is around 320 years old and the only mega city in the eastern region. Its expansion is limited by the river Ganges flowing along its western fringe and marshlands in the east. Thus the city has mainly expanded in the north and south directions. Absence of city planning has led to a haphazard city growth. Road coverage is highly restricted. Kolkata covers 185 square kilometer area under the Kolkata Municipal Corporation (KMC). Kolkata district, which occupies an area of 185 km^2(71 sq mi), had a population of 4,486,679; its population density was 24,252/km^2(62,810/sq mi). This represents a decline of 1.88% during the decade 2001–11 (Census report, 2011). The total no. Of registered fast moving vehicles in kmc area in 2006 was recorded as 11.64 lakhs. The estimated total no. Of motorized vehicles in KMA would exceed 3.5 million by 2025 (www.cseindia.org).Yet, as mentioned earlier the road space, as a percentage of total area, is a mere 6%. Moreover, there is a huge diversity in the modes used. For passenger transport, the city has buses, three wheelers, taxis, trams, two wheelers and private cars plying on the roads as well as the metro, trains and water-ferries. There are both public and private buses, and the latter may be further categorized as ordinary buses, chartered buses, school buses, and minibuses. There are also the non motorized forms of passenger transport (rickshaws and bicycles). All of these factors contribute towards traffic snarls, especially during peak hours.

The objective of the paper is to devise a suitable policy option for controlling the problem of congestion in Kolkata. Various policy options including congestion tax are evaluated and a suitable policy mix considering simultaneous application of different policies are sorted out.

Congestion Pricing

A new vehicle entering a congested road, by increasing the level of congestion and reducing the average traffic speed, imposes a cost on the other users of that road. This cost is a negative externality[1]., as it is not taken into account in the private cost (which is the depreciation and operational cost of a vehicle) incurred by the vehicle owners. It can therefore be called a "congestion externality"**.** There are various components of congestion externality. Nash and Samsom (1999), Delcan et.al. (2003), Vasconcellos and Aquino (2000), and US Department of Transportation (2009) in their studies have estimated the following three components of congestion externality. (a) Time value of delay due to road congestion faced by the road users (b) Excess health cost incurred by the commuters due to emission of excess pollutants from vehicular traffic on congested roads (c) Excess fuel consumption of vehicles traveling at low speed on congested roads . Total congestion externality is the summation of these three cost components.

The present policy regime in Kolkata does not take into consideration this external cost of congestion. If, then we want to correct this by the introduction of congestion pricing, the estimation of the external cost of congestion would be a prerequisite.

Traffic Control Policy in Kolkata

In Kolkata traffic is controlled by adhering to certain traffic control rules and measures. There are also parking restrictions in certain parts of the city. Road users are often fined for violation of traffic rules. The amount of fine is not determined by any study that can provide any scientific basis. Currently, the methods of reducing congestion that are used in Kolkata are (a) to control and restrict traffic (e.g. by the use of traffic lights, allowing only one-way streets), and

[1] A negative externality occurs when an individual or firm making a decision does not have to pay the full cost of the decision. Air pollution from motor vehicles is an example of a **negative externality**. The costs of the air pollution for the rest of society are not compensated for by either the producers or users of motorized transport.

(b) to build new roads or flyovers. The first, which falls under the "Command and Control‟ system, is inflexible and fail to provide incentives for changes in travel behavior or modal choices of the commuters. Although these rules roughly take into consideration traffic movements and congestion problems, there has been no scientific study of congestion in Kolkata, so as to be able to impose a tax directly on vehicles that are creating the congestion. The second is expensive and tends to be a temporary solution, as the ease of travel induces an increase in the number of vehicles on the road. It is therefore necessary to look at measures that would reduce the demand for travel, or the use of personal vehicles for travel. The imposition of a congestion tax that is calculated on the basis of congestion externality is fast gaining acceptance as an alternative policy option in cities (of developing countries) like Seoul, Shanghai, Beijing, Guangzhou and Singapore. However, none of the Indian cities has adopted this policy.

As discussed the present policy regime in Kolkata does not take into consideration this external cost of congestion. If, then we want to correct this by the introduction of congestion pricing, the estimation of the external cost of congestion would be a prerequisite. Congestion varies with unpredictable incident like accident, bad weather, strikes etc. To evolve an effective tax system externalities arising out of road damage and accident should be internalized .Due to lack of relevant data it is difficult to internalize these costs. Such dynamic tax schemes may be both costly and technologically complex to implement in a developing country with scarce resources. It is also necessary to study how far it is worthwhile to introduce such costly technology in an old city with unplanned transport network and extremely limited road coverage of 6%. To end up this discussion it is stated that there are technological, economical or problems of public acceptability for implementation of congestion tax.

Proposed Congestion Pricing Method

The standard economic prescription to internalize the costs of a negative externality[1] is a Pigouvian tax. Pigou (1920) himself argued for a tax on congestion. Also, most economists have supported congestion pricing as congestion pricing represents the single most viable and sustainable approach to reduce traffic congestion (Lindsey, 2006). The objective of this policy is the use of the price mechanism to make road users more aware of the costs that they impose upon one another when traveling during the peak hour, and that they should pay for the additional congestion they create, thus encouraging the redistribution of the demand in space or in time (Button, 1993; Small et al 2007).

Several researchers have presented the methodological steps involved in estimation of congestion externality. Grant-Muller and Laird (2007), Litman (2009) have stated that estimation of congestion externality involves the following steps:

1. Collection of peak and off-peak traffic speed on different categories of road.
2. Calculation of the speed difference between peak period and baseline traffic speed on each type of road and use these results to calculate different components of road congestion externality
3. Using vehicle operating cost models to estimate the additional fuel consumption and pollution emission caused by congested travel.
4. Multiplying delay travel time, additional fuel consumption and emission with unit costs, that is, delay cost / km, additional fuel cost / km, health cost / kg of additional emission of pollutants on a congested road, respectively and summing up to calculate monetary value of congestion externality.
5. Using these estimates to predict the time and total economic savings of specific policy options to reduce congestion.

The baseline traffic speed (Step 2) is based on level of service for different categories of road (Annual Urban Mobility Report published by Texas Transport Institute, in the year 2011). At level of service C[2] (LOS C) the ease of maneuverability declines and average flow speed is 70% of the free flow speed service (LOS) A (free flow traffic). Most economists recommend a more realistic baseline, such as roadway LOS C (i.e., a moderate level of congestion), which maximizes traffic volumes and therefore economic efficiency (Litman (2009), Transport Canada (2006), Taylor (2002)). Also, Bertini (2005) and Cortright (2010) emphasized that baseline transportation speed used for estimation of congestion externality shall be based on LOS C. They have pointed out that

[2]*Level of service (LOS) is the quantitative measures of the quality of service that can characterize operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. LOS are typically denoted by letters A to F.* ***LOS C*** *is a zone of stable flow, but marks the beginning of the range of flow in which the operation of individual users become significantly affected by interactions with others in the traffic stream. The general level of comfort and convenience declines noticeably at this level. Average traffic speeds are about 50% of the free flow speed.* ***LOS E*** *is level of service represents operating conditions when traffic volumes are at or closer to the capacity level. The speeds are reduced to a low but relatively uniform value, average value being one third of the free flow speed. Freedom to maneuver within the traffic stream is extremely difficult, and is accomplished by forcing a vehicle to give way to accommodate such maneuvers. The comfort level is extremely poor and small increase in flow or minor disturbances within the traffic stream will cause breakdowns.*

shift from moderate congestion to free flow state (LOSC/D to A/B) can increase cost since vehicle efficiency declines at higher speed . On the other hand shift from high to moderate congestion LOS E/F to C/D can save energy and reduce emission. They have pointed out that by shifting from LOS C to LOS A there may be a possible increase in fuel use. Moderate congestion (LOS C) reduces traffic speeds to levels that maximize vehicle throughput and vehicle fuel efficiency, although this can be the starting point of congestion (Zhao and Sisiopiku, 1997). A more economically optimal baseline is LOS C/D (45-55 mph on highways), since this tends to maximize traffic throughput and fuel efficiency, and generally reflects user willingness-to-pay, assuming that most motorists would prefer slightly lower peak-period traffic speeds in exchange for much lower road user fees (Litman,2012).

Various methods that are used to calculate congestion costs (Muller and Laird, 2007), are based on the difference between peak and some baseline travel speed. In several developed countries willingness-to-pay (WTP) has become an institutionally accepted means for deriving monetary values from revealed preference studies. This approach is not however represented among the methods currently applied in the transport sector of the less developed world. Due to widespread market failure which detracts from the application of revealed preference methods and the practicalities of eliciting responses to relatively complex surveys in developing countries, the WTP approach has usually been considered inappropriate (Ortuzar et al, 2007).

International Experience on Congestion Pricing

Congestion pricing has been applied in various parts of the world with varying degrees of success. The area licensing scheme (ALS), introduced in Singapore in 1975, and is probably the first . example of congestion pricing. After 23 years in operation, the ALS was replaced by an electronic version called the Electronic Road Pricing System in 1998. In 2003, the city of London introduced a congestion charge scheme in which vehicles entering a 22 square kilometer zone comprising core shopping. Government, entertainment, and business districts were required to pay a congestion charge of £5 between 7 a.m. and 6.30 p.m. on weekdays. The charge has been increased to £8 since July of 2005. Congestion charges not only help to correct transportation externalities but can also generate a significant amount of revenue. For example, annual revenues generated through congestion charges are much higher than the annual operating costs in Singapore and Norway. Congestion charges are thus designed differently depending on the goals. In Singapore, the United States, and the United Kingdom, the primary objective behind road pricing is congestion relief; whereas in Norway it was initially designed to generate revenue and is currently aimed at raising environmental quality and safety. In Singapore and the United Kingdom, motorists pay charges on a daily basis, unlike the United States and Norway where motorists pay a toll per passage. In Singapore, charges vary, depending on peak and off-peak periods. The primary objective of a congestion charge is to reduce traffic congestion. The congestion tax system introduced in London, for example, led to a reduction in city-center traffic of 12 percent, of which 50–60 percent shifted to public transport (Timilsina & Dulal; 2008). It is estimated that daily inbound traffic would be reduced by 5 percent in New York if a toll (set at the level of current tolls on the two parallel Metropolitan Transportation Authority (MTA) tunnels) or a variable charge (with MTA tolls modified to match it) were introduced on the East River Bridge. A London-type congestion charge would reduce daily traffic volume in the city by 9 percent; if full variable pricing were introduced, the reduction could reach 13 percent (Zupan and Perrotta 2003).

Estimation of congestion tax for Kolkata

The encouraging results have prompted me to design a tax scheme for Kolkata. However, the major constraint faced by any researcher in this regard is non availability of data on the benefits accrued by the road users while traveling on various modes of transport on the road. To obtain the congestion tax, I would require the marginal cost and benefit curves. I first derive the marginal private cost and marginal social cost curves. There is data on operational and maintenance costs (per kilometer) for each vehicle type in the manual by IRC (2009). The operational and maintenance cost is Rs. 4.3 per km for a bus, Rs. 1.49 per km. for a car, and Rs. 0.56 per km for a two-wheeler. As there is no separate data for the three wheeler, I have taken the same cost as for a two wheeler.

Table 1 gives the total congestion cost for different traffic flows expressed in PCU. PCU values of different traffic flows are derived using Annexure A. Adding the total private cost for each number of PCUs; we get the total social cost corresponding to each of these PCUs. This is plotted in Figure 1.

Table 1: Calculation of Total Social Cost for Various PCU Values

Vehicles	P.C.U	Congestion Cost (Rs./Km)	Total Private Cost	Total Social Cost (Rs./Km)

			(Rs./Km)	
3000	2314.68	5306.47	3030.55	8337.02
3500	2700.46	7352.12	3535.64	10887.8
4000	3086.24	9959.44	4040.74	14000.2
4500	3472.02	13286.2	4545.83	17832
4665*	3599.33	14577.3	4712.51	19289.8
5000	3857.8	17554	5050.92	22604.9
5500	4243.58	23084.5	5556.01	28640.5
6000	4629.36	30362.3	6061.1	36423.4
6500	5015.14	40153.5	6566.2	46719.7
6664**	5141.68	44107.5	6731.87	50839.4

*** Flow at LOS C ** Flow at LOS E**

Source: Own Calculation

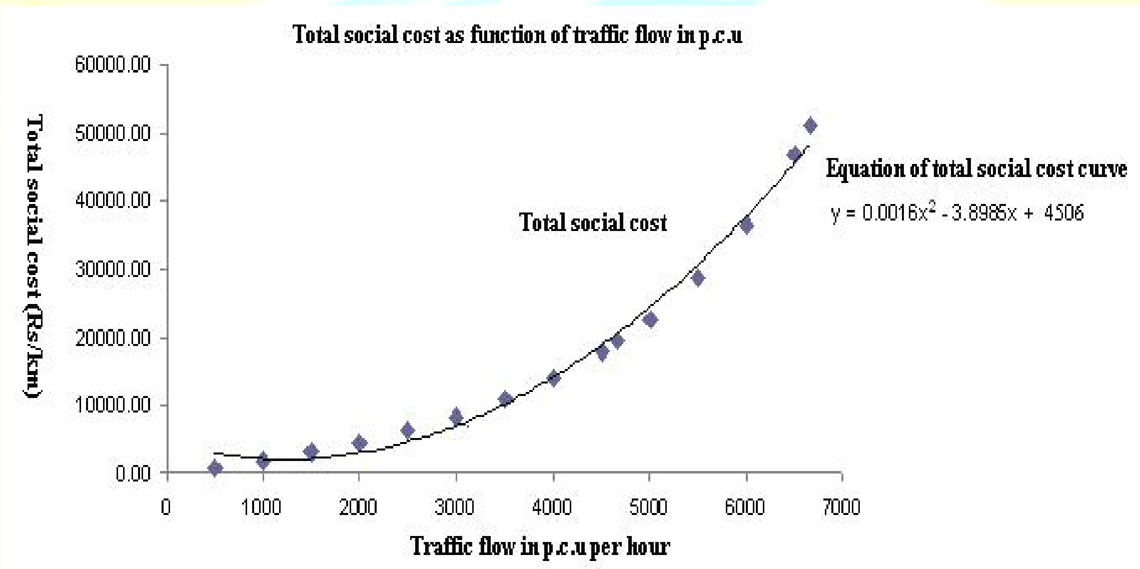

Fig 1: Total Social Cost Curve

The relationship between traffic flow in PCU per hour and total social cost can then be derived using Microsoft Excel, where the best fit is obtained from the scatter plot.

Total social cost = 0.0016 x $(\text{Flow})^2$ – 3.8985 x (Flow) + 4506 ----------------------1

Differentiating the total social cost function with respect to traffic flow one get a marginal social cost (MSC) curve having the equation

Marginal social cost = 0.0032 x (Flow) - 3.8985 --2

Table 2 gives values of PCU (corresponding to various traffic volumes) and their MSCs.

Table 2: Marginal Social Cost (Rs/km) by PCU

Traffic Flow (P.C.U / Hour)	Marginal Social Cost (Rs/Km)
2314.68	2.10
2700.46	3.10
3086.24	4.10
3472.02	5.10
3599.33	5.43
3857.80	6.10
4243.58	7.10
4629.36	8.10
5015.14	9.10
5141.68	9.43

Source: Own Calculation

A rising marginal social cost curve is obtained as shown in Figure 2. In this figure, the traffic flow in passenger car units (PCU) per hour is shown on the horizontal axis. The vertical axis measures marginal benefit and marginal cost in Rs per km. AK is the marginal private cost, a fixed quantity per PCU.

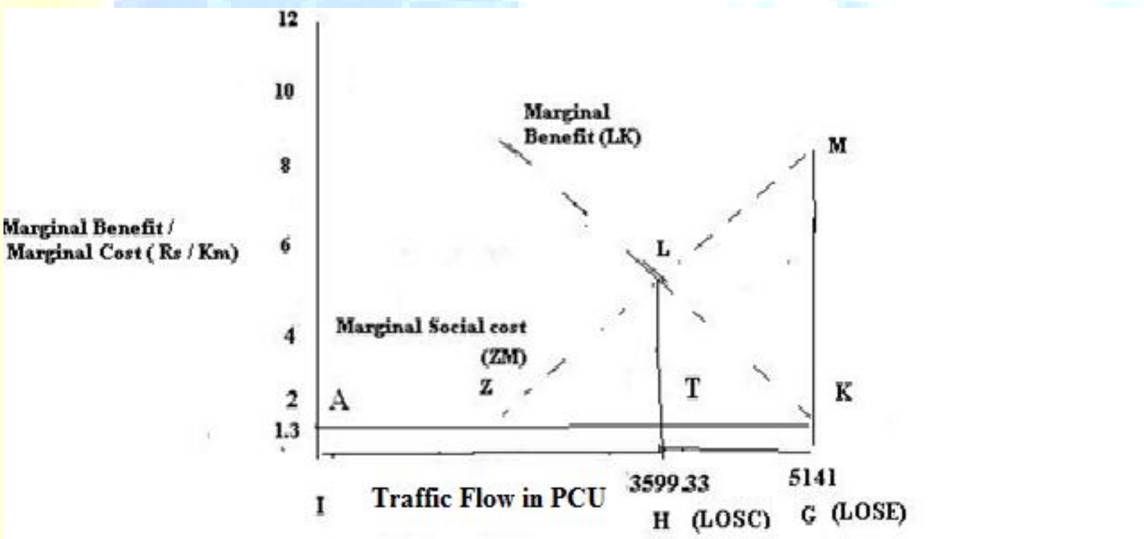

Figure 2 Calculation of Optimal Congestion Tax

Left to themselves, vehicle users opt for the level of service E where the traffic flow almost reaches the maximum capacity of the road. If the point G (in the diagram) represents the level of service E, then I can say that the marginal benefit curve intersects the marginal private cost curve at K, corresponding to the point G. We have not obtained marginal benefit, but I can say, on the basis of our previous statement, that it passes through the point K. Let us then draw a tentative Marginal Benefit curve passing through K. At LOS E (point G), the marginal social cost is much higher than marginal benefit and there is a net welfare loss to society as individual vehicle users are not paying for the congestion cost they impose on the other users. The state should then charge a tax equal to the difference of social cost and private cost (MK in diagram) for each PCU at level of service E. After the imposition of this tax, individual vehicle user's costs will be much higher compared to the benefit they derive at LOS E. Thus the number of vehicles on the road will reduce. As LOS C (at point H, say) is the economically optimal baseline and hence the ideal flow (Littman, 2012), the marginal benefit curve should intersect the Marginal Social Cost Curve at L, above H. In other words, the intersection point of the vertical line from H and marginal social cost needs to be the point through which the marginal benefit curve passes. Hence the vehicle users move from the point G to H, where the congestion cost and hence tax per PCU is LT.

The tax (MK) at LOS E is given by

TE = MSCE - MPCE = 9.43 – 1.309 = 8.12,

As PCU at LOS E is 5141.68, and at that PCU, MSC is 9.43 (see Table 2), and MPC is a constant at 1.309, the tax (LT) at LOS C is given by

TC= MSCC– MPCC = 5.43 – 1.309 = 4.12,

As PCU at LOS C is 3599.33, and at that PCU, MSC is 5.43 (see Table 2) and MPC remains the same at 1.309

Hence, the state should start off by charging a congestion tax of Rs. 8.12 per km. for each PCU, until the PCU drops to the ideal flow of LOS C (3599.33). This optimal would be maintained if the state continues to charge Rs. 4.12 per km. per PCU. This would then be the long term congestion tax. (Table.3)

Table 3: Congestion Tax by Mode (Rs / Km)

Mode	P.C.U	Tax Per Mode (Rs Per Km)*
Bus	2.2	11.4
Car	1	5.2
Two Wheeler	0.5	2.6
Three Wheeler	1.2	6.24

*The values are based on derived tax per PCU of Rs 5.2

Source: Calculated by Using Tax per P.C.U Equal to Rs 5.2

A lot of criticisms are levied against congestion tax.

Some businesses consider themselves harmed by the program, particularly bulk good retailers that rely on customers who drive private cars.

The congestion pricing system uses a network of video cameras to record license plate numbers, and optical character recognition (OCR) technology to read this information, identify "unpaid" vehicles, and generate citations for violators. When first implemented false positives (motorists wrongly ticketed) were common, but failure rates have declined over time as motorists and operators gain experience.

There was concern that congestion may increase on nearby roads due to diverted traffic. Although some diversion occurred the effect appears to be too small to measure, and may be addressed in the future by expanding the priced area and charging more variable fees (higher rates in the centre and lower rates in outer zones).

Some critics argue that road pricing is unfair because it constitutes "double charging," since motorists already pay registration and fuel taxes, and is unfair to lower-income people who must drive. Some motorists are exempting (e.g., people with disabilities) or have substantial discounts (residents within the priced area) not available to others. This criticism has raised debate concerning what pricing is equitable and how reforms can be most fair and beneficial to consumers.

Program costs are high. A substantial portion (about half) of revenues is spent on overhead costs. Critics claim that transaction costs exceed total benefits (Prud'homme and Bocarejo, 2005), but others respond that congestion reduction benefits are higher, there are other categories of benefits to consider, and experience in London will allow development of more cost effective pricing programs in other cities (Mackie, 2005).

Public acceptance is a major challenge. In Hong Kong, by contrast, the failure to communicate benefits and address fiscal and privacy concerns may have created roadblocks during initial consideration of a congestion charging plan.

While technical and public acceptance challenges are significant, they can be addressed for that wish to implement congestion charging. Economic downturns may temporarily reduce congestion and public pressure for policies to address congestion, but the long-term need will continue to grow. In conclusion, congestion charging can often play an important role in reducing the negative effective of congestion while providing environmental and other additional benefits.

Indian Context

The Ministry of Urban Development (MUD), with the objective of reduction of congestion traffic during peak hours, has written to the chief secretaries of states to introduce 'congestion charge' in cities. However such policies are difficult to implement in cities which have multiple entry and exit points (for ex Pune) (Congestion Charging: Indian Tollways). Moreover public acceptability for such a tax is poor since nobody likes to pay an additional tax.

Dr Robin Hickman, an expert in urban transport at London University, said that implementing a congestion charge in Delhi would be "extremely difficult. "It would probably be a better option to increase tax on fuel in the city and invest the funds generated in public transport," Hickman, who has worked in Delhi, said.

Other Policy Options

Thus a need was felt for alternative policy options to cater to the congestion control in India.

High occupancy vehicles like buses may be only permitted to travel over flyovers as a result private car owners may face problems in traveling via congested roads, in CBD areas. Few AC buses with improved traveler's comfort are plying in few routes of Kolkata. With introduction of more of these buses, especially from airport to other parts of the city there will be significant shift in commuter's preferences from taxi and private vehicles to these AC buses.

Out of different modes of mass transport buses reduce congestion because they transport more people per PCU than taxis or personal vehicles. The metro or trains are even better, as they do not occupy the road at all. The implications of policies that shift commuters to these modes of mass transport are studied by means of sensitivity analysis. In each case, a comparison with the ideal policy of congestion taxation is made. In the proceeding analysis different types of modal shifts are discussed.

- Private car to bus
- Two wheeler to bus
- Three wheeler to bus

In Kolkata due to severe space restriction restructuring of the entire transport network is not feasible, but there may be some improvement in the traffic flow on majority of the roads by changing the modal structure as discussed above. Different types of modal choices are evaluated and examined whether there is rise or fall in externality (Table 4).

Table 4 Percentage Changes in Congestion Externality by Changes in Modal Choice

Shifts of Modal Choices	Road Categories	Percentage Changes in Modal Choice	Percentage Fall In Congestion Cost
Car to Bus	2 Lane Two Way	10	-4.5
		20	-8.91
		30	-14.46
		40	-17.82
Two Wheeler to Bus	2 Lane Two Way	10	11.91
		20	2.87
		30	4.3
		40	9.48
Three Wheeler to Bus	2 Lane Two Way	10	0.29
		20	-0.89
		30	-0.23
		40	1.91

Sensitivity analysis is carried out to elucidate the effect of different percentages of modal shifts of road users from various modes of transport to buses. There is 18% fall in congestion externality for 40% modal shift from car to bus (Table 4). On the other hand the changes in externality for other type of modal splits , three wheeler to bus and two wheeler to bus , are not only insignificant, but there is rise in congestion externality in majority of the cases. The above analysis has created ground for future policies aimed at changes in modal preferences of road users from private car to bus. Table.5 shows different percentages of modal shifts of cars (60, 70, 80 and 100 %) to bus. It can be seen from this table that the full congestion externality is internalized at 100% shift of passengers from cars to bus when the traffic flow is 4362 PCU per hour which is below LOS C (4665 PCU / hour). However, 100% shift from car to bus may not be feasible as top government officials on duty, persons traveling on emergencies etc will always use cars. On the other hand, by imposing congestion tax there may be 100% internalization of congestion externality. The tradeoff in this case will be to change modal structure by providing incentives to the road users to use mass transport modes instead of private vehicles. Although congestion taxation is the best policy option, it is still the second best option that is, inducement of road users to shift from car to bus, is more preferred, as explained earlier, because the implementation of dynamic tax scheme is cost prohibitive.

Table 5: Reduction of Congestion Externality Due to Changes in Modal Structure from Car to Bus

Percentage Shift from Car to Bus	Reduction in Congestion Cost (%)	Total Reduced Flow at LOS E (in number of vehicles per hour)	Original Flow at LOS C (in number of vehicles per hour)	Remarks
60%	67.66	5282	4665	Reduced flow at LOS E is above the original flow at LOS C
80%	90.79	4822	4665	Reduced flow at LOS E is above the original flow at LOS C
100%	99.32	4362	4665	Reduced flow at LOS E is below the original flow at LOS C

Source: Own Calculation

It is already discussed in detail that imposition of congestion tax is difficult to implement as it requires highly sophisticated technical instrument which may be cost prohibitive due to scarcity of resources. In comparison to taxation where full internalization of congestion externality is possible, modal shift from cars to mass transport like buses yields similar results, that is, 100% internalization of congestion externality. However, 100% reduction of car from the roads of Kolkata is highly impracticable.. Other policy option discussed above is work trip reduction by either telecommuting or shifting of offices from CBD to outskirts of the city, staggering of working hours, car pooling etc. All the above policy options to reduce work trip may be applicable to some sectors in Kolkata .The above discussion brings forth the need to implement a policy mix to tackle congestion externality in Kolkata Therefore the best policy option will be the mix of various policies.

Conclusion

In Kolkata due to severe space restriction restructuring of the entire transport network is difficult. Congestion varies with unpredictable incident like accident, bad weather, strikes etc. To evolve an effective tax system externalities arising out of road damage and accident should be internalized .Due to lack of relevant data it is difficult to internalize these costs. A dynamic congestion tax schemes may be both costly and technologically complex to implement in a developing country with scarce resources. It is also necessary to study how far it is worthwhile to introduce such costly technology in an old city with unplanned transport network and extremely limited road coverage of 6%. There are also technological, economical or problems of public acceptability for implementation of congestion tax. Hence, ideally, a congestion tax in CBD areas during peak hours can be supported by several additional measures. These include policies to shift road users' preferences from private cars to mass transport.

1. Existing command and control mechanism based on certain preset rules and restriction of traffic flow may be continued.
2. Modal shift of private cars to means of mass transport may be encouraged with incentives to travel in mass transports. Building up metro network definitely reduces congestion but warrants a separate cost benefit analysis before finalizing such high investment.
3. Simultaneously, some of the offices are being already shifted outside the CBD areas and are built at the outskirts of the cities. Reduction in congestion by such changes in land use planning, that is, shifting offices outside CBD areas is an effective policy option.
4. Reduction of work trips is possible in IT sector by means of telecommunicating.
5. Special parking spaces will be provided, in CBD areas, for vehicles who are undertaking car pooling measures by taking several passengers in a single car trip.

Annexure A

Passenger Car Units of Vehicle Categories

Vehicle Type	Equivalent Passenger Car Unit
Bus	2.2
Car/Taxi	1.0
Two Wheeler	0.5
Three Wheeler	1.2

Source: Indian Road Congress (1990)

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