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Travel Demand Management Policies Prospects for Lahore: Rating and Classification

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ABSTRACT
The traffic congestion tends to increase social cost in terms of traffic delays, environmental degradation and energy consumption. It is mandatory to develop appropriate transportation planning and traffic management policies for the mitigation of traffic congestion. In this context, this study focuses to evaluate the potential of transportation demand management (TDM) policies for Lahore city. Few TDM measures were selected and public perceptions were asked using a questionnaire survey. The TDM policies were presented to the respondents in different scenario i.e. single measures, and combination of two measures. Rating and classification was done for the measures using the stated response of respondents. The study's results revealed that non-coercive or pull TDM measures are more acceptable to the public as compared with coercive or push measures. The selected measures were classified into short-term, medium-term and long-term measures. The findings of this paper will be helpful for the local planners in considering the appropriate TDM policies for implementation in Lahore city.

Keywords
Travel demand management, traffic congestion, travel behavior, perceptions, Lahore

1. INTRODUCTION
The rapid increase in urban population and travel demand has resulted traffic congestion and related problems in developing countries. Mobility is an important element of a community and in most of the developing countries; it is mainly dependent on automobile. The trend of automobile ownership and usage has changed the shape of many metropolitan areas and way of travel (Susilo and Kitamura, 2008). The main reasons of increase in automobile ownership and usage are low ownership and usage cost, status symbol, government policies on vehicle ownership, and inefficiency and under development of public transportation systems. Most of the cities in developing countries are facing problem of achieving some appropriate standard of urban mobility. It is unfair to develop more transportation infrastructure just to facilitate private vehicle users and neglecting the mobility of poor people in the society. Presence of such problems has forced the policy and decision makers to provide more supporting and sustainable transportation policies. To overcome the problems of transportation, Sasser (1976) proposed two basic strategies that include "chase demand" and "level capacity" strategy. In the former strategy, the capacity is changed to fit demand and in later one, the capacity is kept constant and demand is controlled. According to Lovelock (1984), balancing capacity and demand is crucial to the success of any activity.

Traditionally, strategies to solve transportation problems and traffic management issues are the "supply side" measures that address simply increasing the capacity of transportation infrastructure. According to the "predict and provide" philosophy the transport planners predict the demand based on demographic changes and vehicle ownership and then provide the infrastructure to meet the demand (Noland and Robert, 2007). The experiences of many cities reveal that as capacity is increased, demand increases at a similar rate and subsequently in the long-term travelers do not experience any benefit and society additionally suffers from the impacts of expensive road infrastructure, environmental degradation, and high-energy consumption. It is argued that transportation policies should not be developed just considering the benefits of automobile travelers at the expense of other road users, which imposes greater external costs to most of the population (Clark, 1997). In developing countries, it is hard to deal with rapid increase in travel demand just by increasing the capacity of infrastructure due to insufficient financial and technical resources. Under these circumstances, it is essential to look for alternative measures such as transport demand management (TDM) rather than just focusing on traditional measures in developing countries.

Transportation demand management (TDM) is a general term for various measures/ strategies that increase efficiency of existing transportation system, and addresses traffic congestion by influencing the travel demand. The primary objective of TDM measures can be explained as "to reduce the number of vehicle trips while providing a wide variety of mobility options to those who wish to travel" (Dorsey, 2005). According to Ferguson (2000), the TDM is a term that is used for different demand side policy measures that encourage the use of existing transportation infrastructure more efficiently, or an approach to influence the behavior of the travelers, with the purpose to reduce the needs of trips or to spread the needs in time and space. It emphasizes the movement of people, rather than motor vehicles, and so gives priority to more efficient modes (such as walking, cycling, ridesharing, and public transit) particularly under congested conditions. It prioritizes the travel based on the value and costs of each trip, giving higher value trips and lower cost modes priority over lower value trips and higher cost travel. The TDM applications focus on each aspects of trip in order to make it efficient.

The TDM measures are considered as effective tools in influencing the travel behavior and have significant impact on reduction in travel time and cost, and convenience of travel options (Garling et al. 2002. Different researchers classify the TDM strategies in different ways. These measures are mainly

classified into two categories such as push or coercive measures, aiming to reduce the advantages of car use (e.g. increase in fuel and road taxes), and pull or non-coercive measures where alternative travel choices are provided (e.g. improved public transport, vanpooling, HOVs lanes) (Steg and Vlek, 1997). Another classification of policies includes hard measures such as road pricing, parking charges, new public transport service and soft measures such as workplace travel plans, personalized travel planning, public transport marketing, and travel awareness campaigns (Garling and Fujii, 2006). In one other classification, the TDM measures fall into two broad groups: 'carrots' or incentives such as HOV lanes for car pools, and 'sticks' or disincentives such as tolls and parking charges.

Many cities around the world, particularly in developing countries are experiencing difficulty in determining appropriate mix of TDM measures to encourage the travelers to change their normal travel behavior, and reduce the transport sector externalities. The level of effectiveness of specific measures implementation depends on the level of transportation problems handled by certain measures. The effectiveness of a TDM measure refers to behavioral change among users of private vehicle or potential users of private vehicle. Urban air pollution originating from transportation activities cannot be solved through one specific strategy; instead, it requires a mix of policy measures that best suit each city's specific circumstances (Molina and Molina, 2004). The mobility of existing public transport users is a critical issue in developing countries because most of them belong to low income group, and public transport facilities are insufficient and/or inefficient. These issues need to address primarily as Banister (2005) said that transport planners have to think more positively about the conditions of public transportation in future in developing countries. The impositions of fuel taxes alone may only account for some externalities but not all, and vehicle ownership taxes may discourage both car ownership and usage (Faiz et al. 1990). Therefore, a well-designed tax on vehicle ownership and usage would be more effective rather than the introduction of these taxes in isolation. Moreover, in a city, where a public transport system is weak, taxes alone do not necessarily result in switching to public transport from private vehicle. In addition to increase in taxes, provision of alternative travel options to private vehicle is important to ensure the sustainability of cities. Alternatives to private vehicle include improved public transport, car/van pooling services, and organizations/institutions based transport services for employees. According to Garling and Schuitema (2007), it is vital to promote such policies, which should reduce the advantage of car use and increase the benefits of public transport usage and other alternatives to private vehicle. Moreover, land use and development is one of the determinants of TDM strategies and has the potential to reshape the population density, urban design, travel needs and travel patterns. Other issue that needs to address in developing countries is the education of travelers because unmannered or disorder travelling/ driving behavior also results transportation problems or misuse of transportation facilities. Considering above stated issues, it is supposed that those TDM policies would be effective which aim to change travel behavior of travelers through education and awareness, keep existing public transport users (e.g. improved public transport, fiscal restrictions on private vehicle), make efficient use of private vehicle (e.g. ride sharing, advance traffic information) and reduce private vehicle trips (e.g. tele-working), provide better alternatives to private vehicle (e.g. improved public transport, ride sharing, office based transport service), and minimize the benefits of using private vehicle through fiscal (e.g. vehicle ownership and usage taxes) and mobility restrictions (e.g. parking limitations, and auto entry restrictions). Moreover, implementation of any measure(s) is not an easy task. For this purpose, it is needed to identify the appropriate measures based on people's perceptions, and proper mechanism to integrate the TDM measures. It is believed that for successful implementation of TDM measures, public acceptability of specific measures is important to evaluate in advance in a specific regions (Schade, 2003; Thorpe et al. 2000; Pkusumantoro et al. 2009). In different studies, push measures like road pricing and parking charges perceived low acceptance from public compared to pull measures such as public transport improvement (Thorpe et al. 2000; Schlag and Schade 2000; Bhattacharjee et. al. 1997). Normally, commuters perceive pull measures to be more appropriate and show more acceptability for them even push measures are often estimated to influence car use reduction to a larger extent (Steg and Vlek, 1997). The main objective of this paper is to identify the suitable TDM measures for implementation in Lahore city through their rating and classification using results of public perception.

2. STUDY AREA AND DATA COLLECTION

2.1 Selection of Study Area and Its Characteristics

Lahore city was selected as a case study city in this paper. Lahore is the second largest city of Pakistan with population of almost 8.65 million and area of about 1792 Km2 (JICA, 2012). It is concentrated with educational, medical and other living facilities. It is also surrounded by small and big size industries which create a lot of job opportunities for the local people as well as for the people living in the sub-urban areas. The presence of such living facilities and employment opportunities attracts people from other parts of the country. The rapid growth in urban population and migration from other areas results huge travel demand which put extra burden on transportation infrastructure. In the last decade, the private vehicle ownership has increased very rapidly at rate of almost 17% per annum (JICA, 2012) and people prefer to use their private transport instead of other modes. Not many efforts have been made in the last decade for the improvement of public transport infrastructure. There is still big bag between demand and supply of public transport facilities despite construction of 27.8 Km bus rapid transit line and launching of conventional bus operation on many routes. The rapid growth in population and vehicle ownership and under development of public transport system result in congestion related problems on road network despite with improvements and addition of supply. Major development is required in public transport sector in order to meet the required demand. Moreover, it is required to consider other TDM measures as stated earlier along with transit improvement in order to tackle with increased travel demand in a sustainable manner.

2.2 Questionnaire Design and Survey

The findings of this paper are based on the results of a questionnaire which was conducted in Lahore city. In this questionnaire various TDM policies were selected for evaluation purpose in two different cases. In first case, all the selected measures were presented individually to the respondents. In second case, combination of TDM measures were designed and presented to the respondents. Table 1 shows the details of case 1 and 2 items. Public transport measure was presented with

improvements in different service attributes. In second case, some pull measures were presented in combination with fiscal policy such as double travel cost of car use which is supposed to achieve by increasing fuel taxes, parking charges and toll taxes. Survey was conducted with the help of graduate students who were trained for this purpose. The survey team members are advised to give information to the respondents before filling questionnaire items. Total 350 samples were obtained for this questionnaire. Almost 73% respondents are male and their main mode of transportation is private car and motorcycle. Public transport modes only constitute little share in the modal share of this study. Most of the respondents are employee of public and private organization and their trip frequency is almost 5-6 days a week.

3. RESULTS AND ANALYSIS

3.1 Ratings of Measures

Evaluated TDM measurers were ranked using the average response of respondents. Public Favourability Index (PFI) term was used for rating, and four indexes used for this purpose i.e. least favourable (LF), moderately favourable (MF), favourable (F), and highly favourable (HF). A measure or measure with given scenario with high favourability mean has more public acceptability for implementation and/or tendency of effectiveness in changing the travel behaviour. Overall average response as presented in table 1 was used for rating of measures from case to case i.e. measures falling in one particular set or case were ranked based on their mutual comparison not with measures of other sets.

The measure with high average score on given scale in concerned set of measures was ranked as highly favourable and with lowest average score as least favourable. Pull or non-coercive measures got more favourability from public among all measures. It can be seen from table 2 that as coerciveness of measure increases its public favourability decreases. It means public perceive push measures as more aggressive compared with pull measures. However, favourability index increases when coercive measures presented with improved public transport scenario or favourability index changes as coerciveness of measures changes. It is argued the people perceptions regarding any measure can be changed by introducing the interaction effect of other measures. Reliability (both travel time and schedule) and higher accessibility (ingress/egress time, transfer, travel cost) are highly favourable attributes of transit improvement. Increase in travel cost of private vehicle usage has significant impact on changing behavioural intentions towards improved public transport.

Table 1: Selected TDM measures for evaluation with average response

TDM Measures		Average response	Scale for evaluation
Individual measures			
Advance traffic information		3.36	A five point Likert scale was used: 1. strongly disagree 2. somewhat disagree 3. neutral 4. somewhat agree 5. strongly agree
Traffic education and awareness programs		2.96	
Public transport improvement	reliable service than car	3.52	
	less travel cost than car	3.41	
	less travel time than car	3.26	
	provides direct access	3.57	
	assured seat with same travel cost & time as car	3.15	
Provision of tele-working		2.75	
Intentions to use office-based transport for reduced cost		2.59	
Increase in parking fee on car use		2.29	
Increase in fuel taxes		2.52	
Increase in road tax or toll		2.71	
Combination of measures			
Improved public transport + parking restrictions at destination		3.12	A five point Likert scale was used: 1. strongly disagree 2. somewhat disagree 3. neutral 4. somewhat agree 5. strongly agree
Improved public transport + 100 PKR parking charges on car use		3.35	
Improved public transport + 100 PKR road tax or toll on car use		3.43	
Improved public transport + car entry restriction in public transport area		3.67	
Double travel cost of car use + improved public transport		3.82	
Double travel cost of car use + policy of office based transport		3.91	
Double travel cost of car use + ride sharing with friends/ colleagues		4.54	

3.2 Classification of Measures

The selected measures were also classified into short, medium, and long term scenario from implementation perspective i.e. which measure(s) need to implement immediately or within few years and which measures need to consider in long term strategic planning. Period of implementation was divided into three terms i.e. short-term (1-2 years), medium-term (3-5 years), and long term (5+ years). Some measures need sophisticated planning and engineering work before implementation that require longer period, whereas some measures can be implemented in short period if people have willingness to accept. Technical and financial resources are also required for implementation of specific measures such as congestion charging and urban rail transit development, which are insufficient in most of the developing countries. Political term and instability, and

institutional incompetency are also contributing factors in deciding the period of implementation. In addition, gradual implementation of various measures is required for gradual change of travel behaviour because behavioural change is not a one-step process. It also requires imposition of specific measures at appropriate time, and mix of different measures as any measure alone cannot be successful in its objective. Consideration of different measures in specific period also depends on extent or nature of the objectives to be achieved in certain time period. Therefore, identification of short, medium, and long term measures is much important in a specific region at initial stages. Some measures are classified only for one term and some for more than one term because some measures need attention at each stage to keep them up to public demands as well as acceptable and effectiveness level.

Table 2 presents the classification of measures based on period of implementation. It is supposed that existing conventional traffic information sources such as traffic radio need to improve and integrate with some other advanced systems in short term. Public education and awareness programs require more time to incorporate and in obtaining the associated objectives; therefore, marked for all scenarios. Provision of tele-working or e-working and office based transport service was treated as short period measures because people have willingness to avail them, and they just need government attentions and ordinance. Public transport improvements were mentioned in all period i.e. in short term exiting facilities should be improved along with development of bus-based transport to medium term. Rail based transit system need to develop in long term in order to deal with rising travel demand, and reduce use of private vehicle. Similarly, fiscal measures were categorized into different period depending on each policy scenario. It is argued to gradually impose and increase annual vehicle registration taxes on both car and motorcycle for proper increase of car ownership and usage cost because it can contribute significantly in controlling the ownership and usage of these vehicles.

Table 2: Rating and classification of selected TDM measures

TDM Measures		**Public Favorability Index**				**Period of implementation**		
		LF	**MF**	**F**	**HF**	**Short**	**Medium**	**Long**
Advance traffic information					√	X		
Traffic education and awareness programs				√		X		
Public transport improvement	reliable service than car				√	Improvements in existing system from operational, capacity & institutional aspects		Development of rail based transit system
	less travel cost than car			√				
	less travel time than car		√					
	provides direct access				√	Development of bus based transport such as bus rapid transit		
	assured seat with same travel cost & time as car	√						
Provision of tele-working				√		X		
Intentions to use office transport	For no reason		√			X		
	For reduced cost			√				
Increase in parking fee on car use		√				X		
Increase in fuel taxes		√				X		
Increase in road tax or toll			√			X		
Improved public transport + parking restrictions at destination (land use)			√				X	
Improved public transport + 100 PKR parking charges on car use				√			X	
Improved public transport + 100 PKR road tax or toll on car use				√			X	
Improved public transport + car entry restriction in public transport area					√		X	
Double travel cost of car use + improved public transport			√			X		
Double travel cost of car use + policy of office based transport					√	X		
Double travel cost of car use + ride sharing with friends/ colleagues				√		X		

Note: LF: least favorable, MF: moderately favorable, F: favorable, HF: highly favorable, '√' indicates public favorability index of a measure, and 'X' indicates period of implementation of a measure

4. CONCLUSIONS

In this paper, various TDM policies were rated and classified using results of public perceptions. It is found that non-coercive or pull measures perceived more public favorability than coercive measures for implementation which is much similar with findings of previous studies. Individually presented coercive measures got low acceptance from public. However, when fiscal policies are combined with some public transport incentives they got more acceptance from the public. It can be said that we need to provide some incentives in terms of improvement in transit facilities if we really want to make proper modal shift and reduce traffic congestion by imposing some fiscal policies. In other words, we need to follow carrot and stick policy as such incentives help in improving the efficiency of imposed TDM policies. In this study, the selected TDM measures are categorized into short-term, medium-term and long-term policies for implementation purpose considering their nature and issues associated in their implementation. The proposed rating and classification of TDM measures in this study would be helpful for policy makers and

other concerned authorities for the mitigation of traffic congestion problems in the Lahore city.

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