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Research Article

Influence of Situational Constraints and Public Transport Incentives on Acceptability of Car Use Restrictions in Lahore, Pakistan

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Abstract: The rapid increase in private car ownership and its usage has resulted in traffic congestion on road infrastructure in Lahore city. It is very important to explore the potential of some travel demand management policies under local socio-economic context. This paper aims to explore the influence of situational constraints and public transport incentives on acceptability of car use restrictions. A questionnaire survey was conducted in Lahore city to obtain the required data. Data was analyzed using structural equation modeling technique. Results revealed that situational constraints and public transport incentives have significant influence on people's travel behavior and acceptability of mobility restrictions on car use. The findings of this study would be useful for local planners in making decision regarding transit improvements and implementing car use reduction measures.

Keywords: Travel demand management (TDM), structural equation modeling (SEM), situational constraints, traffic congestion, public transport

1. INTRODUCTION

The rapid increase in private vehicle ownership and its usage has resulted in traffic congestions on road infrastructure in most of the developing countries. The traffic jams tend to increase social cost in terms of increase in energy congestion and air pollution, increase in travel time and cost, and increase in accidents. Building more road infrastructure results inequitable solutions for the reduction of traffic congestion because it just facilitates the private vehicle users. It does not provide any appropriate mobility options for the poor people such as non-motorized and public transport modes users. Moreover, such supply side measures encourage more private vehicle ownership and its usage, and tend to increase social cost. In developing countries, the main focus is on supply side measures in order to reduce the gap between demand and supply. However, lack of financial, technical and institutional resources and environment sustainability related problems argue from planners and policy makers to look for demand side solutions with supply side measures. In this perspective, travel demand management (TDM) strategies are considered as effective tools in reducing the traffic congestion and its related social and environmental problems. The TDM strategies tend to influence the individual's travel behavior for the reduction of traffic congestion and have impact on reduction in travel time and cost, and convenience of travel options [1]. Garling and Schuitema [2] believe that it is vital to promote such policies that should reduce the advantage of car use and increase benefits of public transport usage. The TDM strategies are mainly classified into two types such as push or disincentive measures aiming to reduce the advantages of car use (e.g., increase in fuel and road taxes), and pull or incentive measures where alternative travel choices are provided (e.g., improved public transport, van pooling, HOVs lanes) [3]. Another classification includes hard measures such as road pricing, parking charges,

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new public transport service and soft measures such as workplace travel plans, personalized travel planning, public transport marketing and travel awareness campaigns [4].

According to Meyer [5], it is required to manage travel demand efficiently for commuting and non-commuting trips and for recurring and non-recurring congestion events in order to optimize the performance of existing transportation system. It is argued that those TDM strategies will be effective in developing countries which offer cheaper travel alternative to the majority of the residents [6]. The TDM measures such as support for ridesharing, public transport improvements and implementation of land use policies can reduce the private vehicle trips. Implementation of parking control measures, and support for pedestrians and cyclists can also be effective in altering the travel demand and pattern [7]. Faiz et al [8] argue that imposing vehicle ownership and other usage related taxes like road tax and parking charges may discourage both car ownership and usage. It is very important to evaluate the public acceptability for the specific TDM strategies before implementing [9] because commuter's behavior will be key factor in their success and effectiveness. In some studies, push measures like road pricing and parking charges perceived low acceptance from public compared with pull measures like public transport improvements [10-11]. However, it is believed that commuters normally perceive pull measures to be more suitable; though push measures are often believed to influence car use reduction to a greater extent [12, 3]. In addition, the acceptability of a measure is important if its objectives have to be achieved [9, 13].

Different factors can influence the acceptability of TDM policies. These factors include individual's socio-economic demographics (SED), lifestyle, attitudes and intentions [3, 12, 17-18]. It is vital to explore the influence of such factors on acceptability of TDM strategies in the local context. Therefore, the objective of this paper is to diagnose the influence of situational constraints or coupling constraints and public transport incentives on acceptability of car use restrictions. The findings of this study are based on results of a questionnaire survey and structural equation modeling. This paper organized in the following manner. Section 2 describes the characteristics of study area and data collection methods. Section 3 presents the results and analysis part and last section summarize the key findings of this study.

2. STUDY AREA AND DATA COLLECTION

In this study, Lahore city selected for case study. It is the second largest city of Pakistan after Karachi and largest one of Punjab Province. The population of Lahore city is almost 8.65 million and area about 1792 km^2 [14]. The urban population growth rate is almost 3% per annum [14]. It is concentrated with educational, economic and medical facilities. The people from other parts of the country travel to Lahore in order to enjoy the culture and better living facilities. The presence of such facilities attracts many people from suburban areas and generates huge travel demand. The number of trips generated is very high from the inner zones of the city due to high density development. Population density varies from 450 persons per hectare in the inner zone to 100 persons per hectare in the outer zone and almost 80% of population is living within a radius of 7-8 km from the city centre [14]. Considering the number of trips generated and attracted due to this high density development in the inner zone and concentration of facilities, it can be argued that Lahore city has high potential for mass transit development. On the other hand, the rapidly growing population and traffic demand has resulted persistent traffic congestion on roads despite significant supply of related infrastructure in the last decade. The ownership of private vehicles is increasing at an alarming rate of 17 % per annum [14]. Insufficient and inefficient existing public transport system is one of the main reasons for this increase. Other main elements in the rapid increase of car ownership and usage are banking leasing policy to own a car, changing lifestyles, status symbol and low ownership and usage cost. It

is believed that motorized traffic also threatens the safety of non-motorized modes users in the busy urban areas [15]. The increased social costs due to heavy traffic congestion in terms of increase in travel time and cost increase in energy consumption and air pollution demands the provision of sustainable travel options. In the context of these stated issues it is required to consider and implement demand management measures in order to solve the congestion oriented problems, and ensure the sustainability of the city.

A questionnaire survey was conducted in Lahore to obtain the required data in order to accomplish the study objectives. A comprehensive questionnaire was designed consisting of following two parts. Part one included only personal and trip information of the respondents i.e. gender, marital status, age, income, education, occupation, vehicle ownership, possesses driving license or not, etc. In part two of the questionnaire respondents were requested to state their behavioral intentions for the use of improved public transport under some situational constraints, mobility restrictions on car use, and public transport incentives. A five point Likert scale was used in this part to evaluate the respondents stated intentions, i.e., never (1), almost never (2), sometimes (3), almost every time (4) and every time/always (5). There were fourteen conditional statements as presented in Table 2 and respondents needed to show their intentions for the use of public transport against each statement using five point Likert scales as mentioned above. The respondents were asked to show their preferences to use public transport under different situational constraints such as travelling alone, travelling with family members or friends, and travelling with elder family members. Some incentives were given to the respondents on public transport usage such as reliable service, direct access to important destinations along transit route, low travel cost and less travel time as compared to private car. Some mobility restrictions on car use were included such as limited car parking space at destination; parking is very far from the destination, imposition of road tax and heavy parking fees on car use, and entry restrictions on car in public transport service area.

This questionnaire survey was conducted in the various private and civil organizations and educational institutions located in Lahore city. The survey locations were selected keeping in view the target groups of respondents. The target groups were included the current and potential car users. Therefore, only those locations were selected for survey where such kinds of travelers were easily available and accessible. These locations included some engineering departments of University of Engineering and Technology and the University of the Punjab, National University of Computer and Emerging Sciences, NESPAK Pvt. Ltd., Transportation Planning Unit (TPU), and some other private organizations. It was assumed that such professional workers and students belonging to engineering fields have more potential to use car.

The questionnaire was equipped with the objectives and details of the conducting authority. The filling guidelines were also mentioned at the start of each part. The respondents were selected randomly at each survey location. The survey was conducted with the help of university graduate students and they were properly trained for this purpose. A pilot survey was conducted before the actual survey in order to assure the clarity of designed questionnaire items. Self-completion approach by respondents was used in this survey. The questionnaires were distributed at selected locations, and instructions were given to the respondents regarding the contents of the questionnaire and the procedure to answer the questions. The respondents were requested to return the completed questionnaire after two weeks, and completed questionnaires were collected with the help of the survey team. An additional one week was given to those respondents who were not able to complete the questionnaire in the initial period.

3. RESULTS AND ANALYSIS

3.1. Distribution of Respondents' Socio-economic Demographics (SEDs)

A total of 550 questionnaires were used in the

survey, and only 372 samples were obtained, which represented a return rate of 67.7%. Eighteen samples were discarded because of incomplete information and double answers on some questions. Therefore, the results of only 354 samples were used in further analysis. The proportions of male and female respondents in the sample were 67.5% and 32.5%, respectively. There were fewer female respondents because they do not ride motorcycles, and the proportion of working women is also lower in Lahore city. Almost 84% of respondents were aged 21–30 years, and only 48% had a driving license. Details of socioeconomic demographics (SEDs) are given in Table 1.

3.2. Average Response on Stated Preferences

Average response was calculated for respondent's behavioral intentions to use public transport under stated conditions. For this purpose, respondents' response was coded on bipolar scale, i.e., -2 (never), -1 (almost never), 0 (sometimes), 1 (almost every time) and 2 (every time).

It can be seen from results presented in Table 2 that respondent's intentions to use public transport vary under different situational constraints. Travelling with family members accounts less average response. It can be said that people feel insecure and less privacy while travelling with family members especially with female. In acceptability of mobility restrictions on use, estimated average response depicts that restriction on car entry in public transport service area has more potential of reducing car use compared to fiscal and parking restrictions. It can be said that improvement in service quality of public transport with car entry restrictions is an effective policy to reduce the traffic congestion in highly congested areas. Parking charges and road tax on car use have almost same influence on car use reduction. In public transport incentives, average response shows that direct access to destination and reliability are the most influencing attributes of public transport along with less travel cost. It looks that sitting has less significance in defining the service quality level of public transport for target group of people.

3.3. Structural Equation Modeling (SEM)

Analyses were conducted using structural equation modeling technique to evaluate influence of public transport incentives and situational constraints on acceptability of car use restrictions. Many studies in the field of transportation research have applied SEM technique to diagnose casual relationship between different factors [16-19]. The SEM is a multivariate statistical analysis tool which can elaborate direct and indirect relationships between

Table 1. Descriptive statistics of respondents' socioeconomic demographics.

Characteristics	Distribution (%)
Marital status	Single (65), Married (35)
Occupation	Students (22.7), private employees (30.6), civil employees (43.1), entrepreneurs (3.6)
Personal income per month (PKR)	< 10,000 (19.5), 11,000–20,000 (13.8), 21,000–30,000 (16.7), 31,000–40,000 (17.2), 41,000–60,000 (17.8), 61,000–80,000 (8.8), > 80,000 (6.2)
Household income per month (PKR)	< 20,000 (4.5), 21,000–30,000 (11.6), 31,000–40,000 (10.5), 41,000–60,000 (24.9), 61,000–80,000 (17.0), > 80,000 (31.2)
Vehicle ownership	None (9.9), Motorcycle (60.2), Car (52.0)
Vehicle driven	None (23.2), Motorcycle (43.2), Car (40.0)
Modal share (usual daily travel mode)	Walk (7.3), Bicycle (1.5), car (31.2), motorcycle (27.6), auto-rickshaw/taxi (12.3), campus/office transport (7.1), Qingqi/wagon (7.2), bus (5.8)
Frequency of usual travel mode	5–7 days a week (86), 3–4 days a week (9), 1–2 days a week (2), a few times a month or less (3)

Table 2. Average response for public transport usage under incentives and restrictions.

Description of items	Mean
Situational Constraints (SC)	
Commuting with family members (SC-1)	-1.083
Travelling with elder family members (SC-2)	-1.232
Commuting with friends (SC-3)	-0.427
Public transport incentives (PTI)	
If public transport is reliable than car (PTI-1)	0.517
When travel cost by public transport is half of car (PTI-2)	0.412
When travel time by public transport is 10 minutes less than car travel time (PTI-3)	0.263
When seat is assured in public transport with same travel time as car (PTI-4)	0.146
When seat is assured in public transport with same travel cost as car (PTI-5)	-0.008
When you can directly access many important places by public transport (PTI-6)	0.576
Acceptability of mobility restrictions on car use (AMR)	
When parking is limited at destination (AMR-1)	0.121
When you need to pay Rs. 100 parking fee at destination (AMR-2)	0.350
When you need to pay road tax Rs.100 for use of car (AMR-3)	0.429
When entry of car is restricted in public transport service area (AMR-4)	0.673

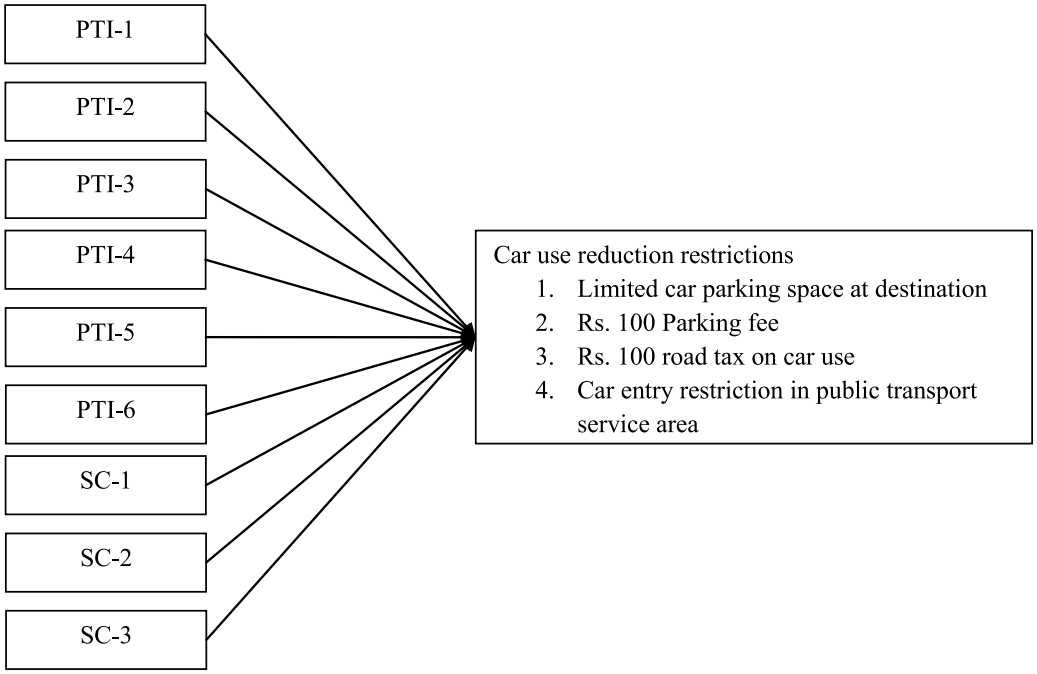

Fig. 1. A typical structural model diagram.

the variables. In a SEM model, it is possible to include latent variables. The SEM technique permits the researcher to interpret the covariance structure without considering the multicollinearity issue. For this purpose various users' friendly software are available such as SPSS AMOS 19.0. A typical structural model diagram for this study is shown in Fig. 1. This diagram shows the influence

Table 3. Results of structural equation modeling.

	Limited parking at destination (AMR-1)	Rs. 100 parking free (AMR-2)	Rs. 100 road tax (AMR-3)	Car entry restriction (AMR-4)
PTI-1	--	.10**	.26***	.32***
PTI-2	.21***	.24***	.24***	.26***
PTI-3	--	.09**	--	--
PTI-4	--	--	-.12***	-.10**
PTI-5	.14***	.07*	.11***	.37***
PTI-6	.12**	.15***	.16***	.12**
SC-1	.24***	--	--	--
SC-2	.29***	--	--	--
SC-3	-.16***	--	--	-.09**

Note: PTI: public transport incentive, SC: social constraints, AMR: acceptability of mobility restrictions, *** significant at 1%, ** Significant at 5%, * Significant at 10%

of public transport incentive (PTI) variables and various situational constraints (SC) variables on a particular car use reduction measures. Table 3 gives the details of significant structural relationships between influencing factors and car use reduction measure. Next sub-sections discuss the results one by one.

3.3.1. Limited Car Parking Space at Destination (AMR-1)

The less travel cost of public transport compared to car has significant and positive relationship with limited parking restriction policy at destination. It implies that limited parking policy has some impact on car use reduction if the public transport travel cost is less. Similarly, in public transport incentives seat assurance and direct access by public transport to most of the destination have positive and significant impact on reduction of car use under limited parking policy. In situational constraints, travelling with family members has positive association with limited parking policy. It means that limited parking policy has significant influence on reduction of car use even when people travelling with family members. The negative relationship between this policy and SC-3 depict that people would prefer to use private car instead of public transport while travelling with friends.

1.3.2. Rs. 100 Parking Fee on Car Use (AMR-2)

The halved travel cost of public transport as compared to car and direct access to important destinations by public transport have very strong association with acceptance of Rs. 100 parking fee on use of private car. It implies that reduced travel cost of public transport along with imposition of parking charges would have significant influence on reduction of private vehicle usage.

3.3.3. Rs. 100 Road Tax Imposition on Car Use (AMR-3)

The provision of public transport incentives has positive influence on acceptability of Rs. 100 road tax on car use. These incentives include reliability, less travel cost compared to car, and higher access of public transport service. The negative relationship of assured seat with same travel time with road tax policy imply that people would prefer to use their private vehicle even if they need to pay Rs. 100 road tax on car use. In situational constraints, none of the relationship is significant with this policy.

3.3.4. Car Entry Restriction in Public Transport Service Area (AMR-4)

The incentives of reliability, less travel cost compared to car and higher access of public transport have positive influence on acceptability of this

policy. However, the incentive of assured seat with same travel time as car has negative relationship with this policy. It depict that this incentive would not help in reducing the use of private vehicle. In situational constraints, people would prefer to use private vehicle while travelling with friends even with the imposition of this policy as relationship is negative.

4. CONCLUSIONS

Reliability of service, less travel cost of public transport and direct access to important destinations by public transport are significant incentives in order to enhance the acceptability of imposed mobility restrictions on car use in Lahore city. It was also revealed that assurance of seat in using public transport with same travel time as private car would not have any impact on reduction of car use even in the presence of mobility restrictions. These findings imply that before imposition of such restrictions on car use we need to enhance the reliability and accessibility of public transport service. It is also required to keep travel cost of public transport on lower side in order to make it attractive for car and non-car users. It was observed that some situational constraints have significant influence on acceptability of car use restrictions such as travelling with friends and family members. People would prefer to use their private vehicle while travelling with friends because they feel better in the society. These findings would be helpful in taking preparatory steps for the improvements of public transport system before imposing above mentioned restrictions on car use.

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