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A STUDY FOR PUBLIC PERCEPTIONS IN INTEGRATING TRANSPORTATION DEMAND MANAGEMENT MEASURES IN DEVELOPING COUNTRIES: A STUDY IN LAHORE

発展途上国における交通需要マネジメント施策に対する受容意識に関する研究 －ラホール市を事例として－

Yokohama National University

Graduate School of Engineering

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ABSTRACT

The rapid increase in travel demand tends to increase social loss by increasing traffic jams and accidents, influence on environment and energy consumption. 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. The experience of many cities reveal that as capacity is increased, demand increases at a similar rate and subsequently in the long-term travellers do not experience a reduction in travel time and society additionally suffers from expensive road infrastructure, environmental degradation, and high-energy consumption. Moreover, in developing countries, it is difficult to deal with increased travel demand just by increasing the capacity of infrastructure due to financial, political, and technical issues. Under these circumstances, it is essential to look for alternative measures i.e. transportation demand management (TDM) measures. The TDM term is used for different demand side measures that encourage the use of existing transportation infrastructure more efficiently, or ***an approach to influence the travel behaviour with the purpose to reduce the needs of trips or to spreading the needs in time and space***. Cities in developing countries are experiencing difficulty in determining appropriate mix of TDM measures to encourage travellers to change their normal travel behaviour. In this study, it is supposed that those TDM measures would be effective which aim to keep existing public transport users, make efficient use of automobile and reduce private vehicle trips, provide alternatives to private transport, and minimize the benefits of using private vehicle through fiscal and mobility restrictions.

Factors influencing the public acceptability and effectiveness of specific measures are essential to evaluate in advance in specific region. Few studies in developing countries provide the evidence of influence of income, education, gender and social and religious factors on acceptability and effectiveness of TDM measures. On the other hand, studies in the developed countries have shown many factors i.e. pro-environmental behaviour, problem awareness, individual freedom in mode choice, personal and social norm, situational factors, and value orientation. Other factors such as individual's lifestyles, attitudes, personality, freedom, status, superiority, feelings of power, and perceived performance of each transport mode seem to play an important role in policymaking. From perspective of developing countries, it is also required to evaluate the influence of above stated factors in integrating the TDM measures. Moreover, design of questionnaires to grasp stated preferences is a critical task due to difficulties in getting reliable data for making significant inferences. The respondent's literacy level and response rate are the main issues when questionnaires include items regarding personal information, lifestyles, attitudes, norms, and intentions. Applications of theory of planned behaviour (TPB) and norm-activation model (NAM) are also not sure in explaining the behavioural consequences of TDM measures. Therefore, this study aims to design questionnaires for grasping user's preferences to investigate the influencing factors in integrating TDM measures in developing countries for mitigation of traffic congestion and related environmental and social problems.

Lahore city is selected for case study considering the severity of transportation problems, and feasibility of conducting the surveys. It is the second largest city of Pakistan with population almost 8.65 million. Three questionnaires were designed and conducted in Lahore city. Survey related to traffic radio first was conducted through email and then in field during September 2011. Phase-I survey was conducted with the help of university graduate students during September 2011 and 631 usable samples

obtained. Phase-II survey was conducted during September-October 2012 again with the help of university graduate students and 354 usable samples obtained. Structural equation modelling techniques were used to analyze the questionnaires data.

Study results revealed that radio traffic information has significant influence on road user's trip making decision, and such simple, audio, and conventional type traffic information sources are suitable in developing countries considering literacy and accessibility issues of travellers. Effectiveness of such traffic information source depends on listening propensity of travellers and their satisfaction with its service quality. Two types of travel pattern exist in Lahore i.e. auto dependent, and non-auto captive behaviour. Time saving, convenience, reliability, flexibility, status symbol, and freedom are main motives in the use of private vehicle and auto-rickshaw, whereas low income and non-vehicle ownership are main reasons of non-auto modes usage. Symbolic, functional, and cost and time factors are significant determinants of public satisfaction with the service quality of public transportation modes and people perceive different modes differently. Daewoo bus service with some service improvements has potential of reducing the inefficiency of existing public transport system. Auto-oriented lifestyles and attitudes tend to reduce, whereas transit oriented factors tend to enhance the usage of public transport. Personality traits, community and congestion oriented travel attitudes, perceived behavioural control and intention are underlying factors of public attitudes towards soft, pull and push measures. Heterogeneity exists between different mode users for lifestyles and attitudes and perceptions to TDM measures. Similarly, attitudes towards public transport, personal and social norms, perceived behavioural control over public transport, perceived freedom and flexibility in travelling, and status oriented factors are significant factors influencing the acceptability of improved public transport, office based transport, and combined fiscal policy. Situational factors, mobility restrictions on car use and people moral obligations have significant impact on people's intentions towards improved public transport. Perceived attitudinal aspects of private car and public transport such as social/aesthetic and personal orderliness and instrumental are also determinants of people's attitudes towards public transport.

Studied TDM measures were ranked and classified in terms of public favourability index and period of implementation respectively. People perceive soft and pull measures more favourable over push measures. However, push measures have more potential of changing travel behaviour. Polices were developed of appropriate TDM measures under their influencing factors for integration in developing countries. Intervention packages of TDM measures have been proposed to change and activate different attitudes, norms and beliefs, and create awareness among people about merits and demerits of different travel alternatives. Integration of fiscal and mobility restrictions on private vehicle use with public transport improvement and other travel alternative has tremendous potential of changing people's travel behaviour. Behavioural theories can be applied in isolation as well as in combination in determining the behavioural intentions to TDM measures.

This study infers that individual lifestyles, attitudes, norms, and perceived performance of transportation modes are dominant aspects of travel behaviour in integrating the TDM measures, and such aspects can be grasped in developing countries by giving proper attention to questionnaire design and survey methods. However, local circumstances of concerned city should have more importance in designing the appropriate set of policies. At the end, recommendations have been made for future research relevant to the scope of study with putting emphasis on designing stated preference experimental design in order to evaluate the interaction effect between TDM measures.

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Dedicated to my beloved parents and family, and respected teachers

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LIST OF ABBREVIATIONS/ NOTATIONS/ TERMINOLOGIES

TDM	Transportation/ Travel Demand Management
TSM	Transportation System Management
MM	Mobility Management
Auto/ automobile	the term or word auto/ automobile in this study describes private vehicle (both car and motorcycle), taxi and auto-rickshaw unless or until these modes described specifically
Measure or Strategy	Both words are being used interchangeably to describe the TDM policies at various places throughout this dissertation
BRT	Bus Rapid Transit
NMM	Non-Motorized Modes
LMA	Lahore Metropolitan Area
GoP	Government of Punjab
LTC	Lahore Transport Company
JICA	Japan International Co-operation Agency
ADB	Asian Development Bank
GDP	Gross Domestic Product
SED	Socio-Economic Demographics of respondents
CBD	Central Business District
HOV	High Occupancy Vehicle
ERP	Electronic Road Pricing
VQS	Vehicle Quota System
TPB	Theory of Planned Behaviour
NAM	Norm Activation Model
SEM	Structural Equation Modelling
TA	Travel Attitudes
PT	Personality Traits
PBC	Perceived Behavioural Control
APT	Attitudes towards Public Transport
SN	Subjective or Social Norms
AC	Awareness of Consequences
AR	Ascription of Responsibility
PN	Personal Norm
PFF	Perceived Freedom and Flexibility
SST	Social Status Traits
PFEP	Perceived Feasibility of Environmental Protection
JSM	Joint Structural Model
PKR or Rs.	Pakistan Rupees
Chi-sq/ DF	Ratio of Chi-square to Degree of Freedom
GFI	Goodness of Fit Index
AGFI	Adjusted Goodness of Fit Index
CFI	Comparative Fit Index

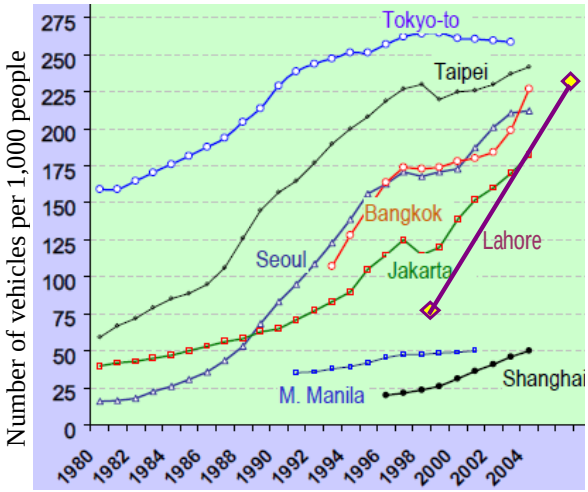
RMR	Root Mean square Residual
RMSEA	Root Mean Square Error of Approximation
α	Cronbach's Alpha
R^2	Percentage (%) of variance explained

Chapter 1

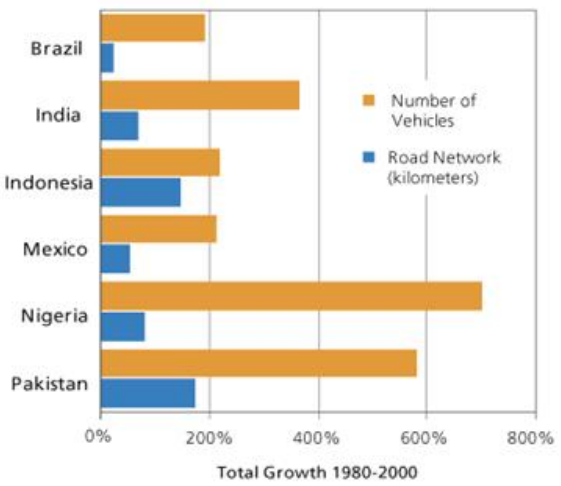
INTRODUCTION

1.1. BACKGROUND

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. Non-motorized transport, which was the common mode to link different places in earliest times, has replaced by car largely in daily mobility, and by trucks for freight movement (Fjellstrom, 2002). Even now in some countries, walking and public transport are modes of transport for poor people. 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. The rate of vehicle ownership growth is more in some cities of developing countries compared to developed countries as shown in figure 1-1(a). On the other hand, figure 1-1(b) shows that the difference is much larger between increase in vehicle ownership and road network development in developing countries, and same situation can be imagined in major cities of these countries. It occurs due to lack of financial, institutional, and technical resources as well as political issues. This difference and the rapid increase in automobile traffic tend to increase social loss by increasing traffic jam and accidents, and influencing on environment and energy consumption.



(a) Growth of vehicle ownership in different Asian cities (**Source:** *JICA final report 2012 on Lahore urban transport master plan*)



(b) Vehicle ownership and road development pattern in different countries of world (**Source:** *Earth Trends, 2006, from the International Road Federation, 2003*)

Figure 1-1: Pattern of vehicle ownership and road development

Most of the cities in developing countries are facing problem of achieving some appropriate standard of urban mobility. It is very unfair to build more road infrastructure just to facilitate private vehicle users and neglecting the mobility choices of poor people

in a society. Occurrence of such transportation problems has forced the policy makers and other stakeholders 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. It is required to emphasize on evaluating the relationships between the nature of demand, basic risk of measure, and the amount of capacity needed, and to consider the demand side measures and their influencing factors at planning and decision making stage.

1.2. APPROACHES FOR MITIGATION OF TRAFFIC CONGESTION

The major reasons of traffic congestion include imbalance between demand and supply, inefficiency of transit facilities, disorder driving behaviour, land use issues, traffic management and enforcement issues, accidents, work zones, bad weather and un-expected events. There are three ways to deal with traffic congestion and related transportation externalities as follows; supply side measures, transportation system management (TSM), and transportation demand management (TDM) measures.

1.2.1. Supply side measures

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). These supply side measures include development of road infrastructure, which include ring roads, bypass, bridges, elevated expressways, pedestrian and bicycling facilities, flyovers, underpasses, etc. and public transportation services. The experiences of many cities reveal that as capacity is increased, demand increases at a similar rate and subsequently in the long-term travellers do not experience a reduction in travel time 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 travellers at the expense of other road users, which imposes greater external costs to most of the population (Clark, 1997). In developing countries, it is very hard to deal with rapid increase in travel demand just by increasing the capacity of infrastructure due to insufficient financial and technical resources. Political and institutional issues are also contributing factors in resulting of insufficient and inefficient road infrastructure and transit facilities. Under these circumstances, it is essential to look for alternative measures rather than just focusing on traditional measures in developing countries. These measures include transportation system management (TSM) and transportation or travel demand management (TDM) measures.

1.2.2. Transportation system management (TSM) measures

This approach focuses on increasing the efficiency, safety and capacity of existing transportation systems through the implementation of intelligent information systems (ITS) or simply more efficient use of existing supply rather than providing more supply. In other words, using these TSM measures we attempt to enhance the capacity of existing transportation system without adding any supply. Initially, the TSM approaches have

been treated as traffic management measures that used to influence individual travel behaviour. Importantly, the foundation for TDM policy will be linked to a policy initiative, called transportation system management (TSM) that resulted in most urban areas developing TSM plans in the late 1970's in USA (Meyer, 1999). Major TSM measures include; real time driver and transit information for effective trip planning, incident response plans, targeted traffic enforcement (provision of high occupancy vehicle lanes), improvements in existing services (traffic signs, signal timing, bus priority signalling), and low cost improvements in existing public transportation modes.

1.2.3. Transportation or travel demand management (TDM) measures

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 (individual's travel behaviour) rather than increasing the capacity. The origin of TDM can be traced back to time of World War II, when company buses, carpools, and staggered work shifts were introduced to attract employees and manage on-site congestions problems (Giuliano and Watchs, 1992). However, demand management programs were actually implemented in USA during 1980's before that different terminologies used for these programs such as traffic management and transportation system management (TSM) measures. 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 behaviour of the travellers, 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 framework include wide range of policies and programs that influence how, why, when and where people travel in order to make travel behaviours more sustainable, and figure 1-2 shows this TDM concept. 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 behaviour and have significant impact on reduction in travel time and cost, and convenience of travel options (Garling *et al.* 2002). Generally, the TDM measures have following advantages: more inherently equitable, cost effective alternatives to supply, reduction in environmental impacts and energy consumption, enhance safety, accessibility and mobility, and increase in economic productivity. The change of travel behaviour in response to specific TDM measure can be categorized into following types: route change (spatial distribution of travel demand e.g. real time traffic information), travel mode change (promotion from private vehicle to other travel alternatives, park and ride), departure time change (temporal distribution of travel demand e.g. provision of flexible and staggered working schedule), trip generation frequency change (compressed commuting, need based travel, and promotion of tele-work and e-business), and efficient usage of automobile (vehicle occupancy limitations for travelling e.g. HOVs lanes).

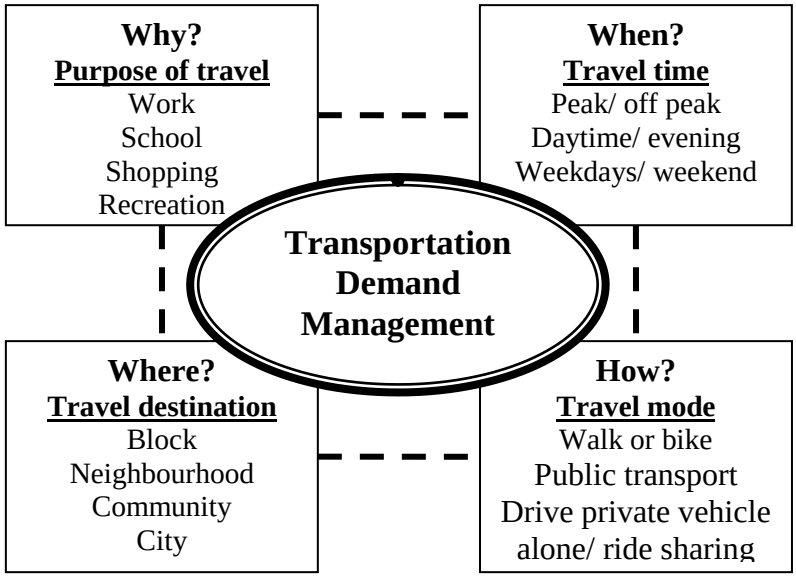


Figure 1-2: Basic concept of TDM (Source: Transport Canada)

1.3. STATEMENT OF PROBLEMS

In developing countries, planners and authorities always feel hesitation in introducing the traffic constraint measures for relieving traffic congestion. The implementation of TDM strategies especially fiscal ones always faces low favour from politicians due to low level of public acceptance. The often-cited excuses are the intrusion of the citizens, burden on people, privacy, and lack of freedom. Most of the researchers and planner firmly believe that implementation of parking and traffic restraints are major tools in managing the traffic congestion. However, in reality it is not a simple task to accomplish such measures even in developed countries. Strict law enforcement is required to implement TDM policies, and make them successful in their objectives. This study does not focus in detail on political, legal, technical, economic, and institutional aspects of TDM measures although they are important elements in implementation and success. *This research only focuses on public/social aspects in incorporating the TDM measures in developing countries, and assumes that the selected measures in this study are feasible from above stated aspects under given circumstances.*

Many cities around the world, particularly in developing countries are experiencing difficulty in determining appropriate mix of policy measures (incentive and/or disincentive measures) to encourage the travellers to change their normal travel behaviour, 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 behavioural change among users of private vehicle or potential users of private vehicle (in this study). 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. This issue 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 travellers because unmannered or disorder travelling/ driving behaviour 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 behaviour of travellers 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 under their influencing factors in developing countries.

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 that whether a specific strategy will effectively change travel behaviour or not (Schade, 2003; Thorpe *et al.* 2000; Pkusumantoro *et al.* 2009; Limapornwanitch *et al.* 2003). With respect to attitudes towards TDM measures, a difference is necessary to made between acceptability and acceptance of a measure. *Acceptability* refers to the attitudes before the implementation of a potential future TDM measure, and *acceptance* refers to the attitudes held after the implementation of a measure (Schade & Schlag, 2003a, 2003b; Schlag & Teubel, 1997). People's behaviour can be a key issue in the success of any policy measure. In developing countries, few studies provide the evidence of influence of income, education, gender and social and religious factors on acceptance and effectiveness of different TDM measures (Bhattacharjee *et. al.* 1997; Pradono *et al.* 2009; AB Rahman, 1993). These factors may provide a narrow picture of people's behavioural intentions to TDM measures, and scope of transportation policies extracted from these factors may be limited. On the other hand, many studies in the developed countries have shown other factors along with socio-economic demographics (SED) that are important in the acceptability and effectiveness of TDM measures i.e. pro-environmental behaviour, problem awareness, individual freedom in mode choice, personal and social norm, situational factors, value orientation and environmental beliefs (Eriksson *et al.* 2006, Schade & Schlag, 2003; Stern *et al.* 1995 & 1999). Beirao and Cabral (2007) argue that the important features need to consider in policy making concerning about transportation is the current and changing nature of society and lifestyle patterns that generate diversified travel demands. Other instrumental factors seem to play an important role such as feelings of power, freedom, status, and superiority (Steg, 2005). Cao and Mokhtarian

(2005a, b) state that travel related measures are likely to be affected by individual's travel attitudes, personality, and lifestyles. People's intentions to use public transport are also influenced by individual characteristics and situational factors (Steg, 2003), and perceived service performance of each transport mode (Beirao and Cabral (2007). Moreover, many Asian people tend to believe that owning an automobile is a social status symbol, and they drive not only for mobility needs but also as a status symbol. From perspective of developing countries, it is also needed to evaluate the influence of above stated factors in integrating the TDM measures. Therefore, it is hypothesized that individual's socio-economic characteristics, lifestyles, personality, status symbol, freedom, flexibility, attitudes, social and personal norms, awareness of problems and sense of responsibility, and perceived performance of transport modes are likely to affect the individual's behavioural intentions to selected TDM measures. However, such factors may affect the consideration of each measure differently.

Stated preference approach can be applied to grasp public perceptions in order to investigate the factors influencing the acceptability and effectiveness of TDM measures. However, design of questionnaire to grasp public perceptions and preferences in developing countries is a critical task due to difficulties in getting reliable data for making significant inferences related to topic under study. Respondent's literacy level, privacy, and response rate are the main issues when a questionnaire includes items regarding personal information, lifestyles, attitudes, norms, and intentions. These issues of respondents affect the questionnaire design procedures and methods of conducting the surveys. Inclusion of statements relating to above stated factors and evaluation on ordinal scales tend to generate lengthy questionnaire; as a result, more time and attention is required from respondents in answering the questions. Applications of behavioural theories in isolation as well as in combination are also uncertain in developing countries in designing questionnaires for explaining the behavioural consequences of TDM measures. People show reluctance in sharing personal and household information, and even opinion on other stated questions. A low response rate or improper response on stated questions can result insufficient data or samples and biased information that can affect the findings of a study. Therefore, special attention is required when conducting a questionnaire survey in developing countries from perspectives of selection of target group(s) and questionnaire items, selection of questions wording and measurement scales, placement of questions and different questionnaire parts, and selection of survey methods. In-depth or detailed interviews with users can provide a deeper picture of factors governing the use of different modes. However, these interviews are time consuming or required more time to conduct, and need good response and interest from the people in order to get sufficient samples and information for making significant inferences. Analysis of such qualitative data also takes longer time.

In general, this research addresses the following issues:

- What kinds of TDM measures are suitable to keep existing public transport users or to restrict non-private vehicle users from owning and using a private vehicle (in other words, measures to address issue of mobility of existing transit users), to reduce private vehicle commuting trips, and to make promotion from private vehicle to public transport and other travel alternatives.
- What factors do we need to consider in integration those measures in developing countries?
- How can we investigate such factors and what kinds of questionnaire and survey approaches are appropriate in this context?
- Under those significant factors, what should be mechanism to integrate TDM measures in Lahore as well as in cities of other developing countries?

1.4. GOAL AND OBJECTIVES OF STUDY

Goal of study: to propose a framework of TDM measures based on public perceptions for integration in developing countries to assure proper mobility of people belonging to different socio-economic groups, and mitigate traffic congestion and related economic, environmental, and social problems by selecting Lahore as a case study city.

To achieve this goal, following objectives have been set:

1. To evaluate the influence of radio traffic information on road user's trip making, and factors affecting the road user's future preferences with the traffic radio ***(chapter 4)***
2. To evaluate public perceptions for satisfaction with existing public transportation, and attitudes towards TDM measures considering lifestyles and attitudes ***(chapter 5)***
3. To diagnose the factors influencing the acceptability of TDM measures using behavioural theories as a frame of reference for questionnaire design ***(chapter 6)***
4. To identify the factors influencing the commuter's attitudes towards public and private transportation modes through questionnaire survey and detailed interviews ***(chapter 7)***
5. To develop policies and a framework of appropriate TDM measures for integration in Lahore as well as in cities of other developing countries ***(chapter 8)***

1.5. SCOPE AND LIMITATIONS OF STUDY

The findings of this research would help in implementing the suitable TDM measures to alleviate traffic congestion, and reduce environmental and social problems. The study main applications include:

- ✓ It tells the importance of radio traffic information in making effective trip planning, and scope of such traffic information media in developing countries.
- ✓ This study explains the mechanism of underlying factors of travel behaviour from socio-economic demographics (SEDs), lifestyles, and social-cognitive aspects.
- ✓ This study suggests the significant influencing factors that need to consider in designing appropriate sets of specific TDM measures for integration in case study city and cities of other developing countries.
- ✓ This study provides the evidences of grasping public perceptions from aspects of lifestyles and attitudes, and applications of behavioural theories in developing countries.

Beside several applications, this study has following limitations:

- ➘ As sample size is limited in questionnaire surveys and interviews, and target groups are specific segments of travel market; therefore, the findings may not reflect the perceptions of whole community or all groups of travel market.
- ➘ The TDM measures need to consider with the supply side measures as transportation infrastructure is in developing stage in developing countries. No single policy can solve the urban transportation problems. Highways, transit, system management, and package of TDM strategies all have to play a role.
- ➘ It is difficult to generalize the underlying factors and measures for solving transportation problems in all developing countries. In other words, lessons learned from one community/ studies in one region are not transferable to another. Success in implementation of any measure depends on local circumstances.

1.6. STRUCTURE OF THESIS

Chapter 2: This chapter describes the research background and motivation. It includes classification schemes of TDM measures, scope of TDM measures, implementation cases of TDM measures and academic studies regarding evaluation of factors influencing the acceptability and effectiveness of TDM measures in both developed and developing countries. Analytical and methodological background has also been presented relating to application of behavioural and attitudinal theories in travel behaviour research.

Chapter 3: This chapter describes the various steps of research methodology. These steps include selection of case study city and specific TDM measures for study, data collection methods, and background of data analysis methodologies. It also describes the characteristics of study area i.e. Lahore city.

Chapter 4: This chapter elaborates the importance of existing traffic information source i.e. radio traffic information, and main features of traffic radio set-up in Lahore. It further discusses the survey results relating to evaluation of listing propensity of traffic radio and its influence on change of travel behaviour. A structure of road users listening propensity, satisfaction and future preferences with the traffic radio has also been developed in this chapter.

Chapter 5: First part of this chapter evaluates the potential of existing public transportation in terms of satisfaction and preferences with public transportation. Second part presents the results relating to public attitudes towards TDM measures under the influence of people's general lifestyles, travel attitudes, and intentions.

Chapter 6: This chapter elaborates the application of behavioural theories in the design of questionnaire for determining the factors influencing the acceptability of TDM measures. A Joint-Structural-Model of behavioural theories has been developed for this purpose in this chapter.

Chapter 7: This chapter presents the results of people's preferences towards transportation modes considering situational factors, mobility restrictions and incentives and moral obligations. Results of detailed interviews are also presented in this chapter.

Chapter 8: Considering the results of previous four chapters, policies have been developed in this chapter and conceptual framework of TDM strategies proposed. This chapter also proposes the rating and classification of selected TDM measures.

Chapter 9: This chapter summarizes the main findings and policy implications of this study. At the end, recommendations are made for future research.

Chapter 2

RESEARCH BACKGROUND AND MOTIVATION

This chapter presents the material related to research background and motivation. Extensive literature was reviewed both from developed and developing countries perspective regarding implementation cases of TDM measures and academic researches focusing on evaluation of factors influencing the acceptability and effectiveness of TDM measures. The contents of this chapter include various classification schemes of TDM measures, scope of TDM measures consideration and implementation cases of TDM measures in both developed and developing countries and their related issues, literature regarding factors affecting the acceptability and effectiveness of TDM measures, significance of mobility management measures in changing travel behaviour, application of behavioural theories in travel behaviour research, and theoretical definitions of various terminologies that are used in this research.

2.1. CLASSIFICATION SCHEMES OF TDM MEASURES

The basic principle of TDM is to influence the individuals travel behaviour. As defined by Meyer (1999), the TDM can be seen as 'any action or set of actions aimed at influencing people's travel behaviour in such a way that alternative mobility options are presented and/or congestion is reduced'. Different researchers classify the TDM strategies in different ways. These measures are mainly classified into two categories such as ***push measures***, aiming to reduce the advantages of car use (e.g. increase in fuel and road taxes), and ***pull 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. Table 2-1 enlists these classification schemes and related measures.

Tanaboriboon (1994) classified six different TDM strategies ranging from the immediate measure of ride sharing to long term solutions on the land use control strategy. These six TDM strategies are traffic control, public transportation improvement/priorities, peak period dispersion, ride sharing, parking controls, and land use control. On the other hand, Flynn and Glazer (1989) have mentioned seven TDM strategies utilized in ten major U.S. cities. These seven strategies include; region wide ride share agencies, developer requirements, transportation fees, incentive ordinances, transportation management organizations, employer ride share ordinances, and comprehensive TDM ordinances. In similar to TDM concepts, Jraiw (1990) has proposed a balanced method between demand on the road transportation system and the supply which covered the following techniques: road pricing, parking management, partial banning of traffic, public transport improvements, new road construction, land use planning, improvements to the existing road network, alternative work hours, and ride sharing. Different TDM strategies can be consider based on the nature of traffic problems, land development pattern, and socio-economic characteristics and changing nature of concerned city in which TDM

strategies are going to be implemented. Table 2-2 classifies a number of TDM measures into different types aimed at influencing people's travel behaviour. This classification list of measures is by no means comprehensive but is indicative of the types of measures available to transport planners and engineers as a means of bringing about a change in travel behaviour. Clearly with the number of these measures proposed in table 2-2 are issues relating to effectiveness, acceptance, and implementation.

Table 2-1: Classification schemes of TDM measures

Soft or Psychological	**Hard or Structural**
• Information and awareness about pros and cons of car use and other travel alternatives • Individualized travel planning • Work place travel plans • School travel plans • Travel awareness campaign • Public transport improvements • Promotion of sustainable travel option	• Land use policies • Legal restrictions • Economic incentives and disincentives ✧ Road pricing and carbon tax on fuel ✧ Parking fees ✧ Subsidies on transit facilities • New public transport service • Improvements of bike and walk paths
Pull or Non-coercive	**Push or Coercive**
• Information campaign and awareness • Improved public transport • Tele-working • Ride sharing programs and car/ van pooling • Compressed and staggered working hours	• Increased taxes on fuel • Road pricing • Parking managements • Land use policies
Carrots or Incentives	**Sticks or Disincentives**
• High occupancy vehicle lanes • Car and van pooling • Ride sharing programs • Public transport improvement	• Parking charges • Road pricing or tax • Carbon tax • Land use policies

Table 2-2: A generalized classification of types of TDM measures

Type	**Measures**
Economic measures	✧ Fuel tax ✧ Road user charging or congestion charging ✧ Parking charges ✧ Subsidies on public transport
Land use	✧ Car free developments and location of new developments ✧ Park and ride facilities ✧ Designated areas for commercial and business activities ✧ Pedestrianized zones
Transit improvements/ development	✧ Bus based service ✧ Para-transit mode ✧ Rail transit
Information for travellers	✧ Travel information before a trip is undertaken ✧ Car sharing or ride sharing ✧ Bike sharing
Communicative measures	✧ Traffic education at school level ✧ Awareness and social marketing campaigns
Substitution of communications for travel	✧ Tele-working ✧ E-shopping ✧ E-government
Legal/	✧ Parking controls (parking prohibition, preferential treatment for HOVs)

administrative measures	✧ Pedestrianized zones ✧ Alternative working patterns (flexible working schedule) ✧ School, college and university transport for students ✧ Transport for employees or workers or work place travel plans

2.2. SCOPE OF TDM MEASURES IN DEVELOPED AND DEVELOPING COUNTRIES

Now-a-days, managing travel demand has widened the desire to optimize performance of transportation system for commuting and non-commuting trips and for recurring and non-recurring congestion events (Meyer, 1999). The TDM measures can be implemented on a nation-wide basis, such as with fuel tax, on an area-wide basis as with road user charging or park and ride, or on a sites specific basis with measures such as parking restraint on a university campus. The TDM measures can seek to focus on the short-term mitigation of congestion or can seek to take a more long-term strategic approach by focusing on land use patterns. Generally, the TDM measures are implemented based on conditions of development, land use pattern, local ordinances, and cover from individual firms to large-scale geographic areas. The scenarios of TDM measures implementation are different between developed and developing countries from many perspectives i.e. pattern of automobile ownership growth (saturated versus unsaturated), existing road infrastructure and transit facilities (developed or developing or underdeveloped), social, economic, political, technical and institutional aspects as mentioned at the top of table 2-3. The focus in developed countries is to change or influence the travel behaviour of car users i.e. how can we make efficient use of private vehicle and how can we shift car users to developed public transport and other travel alternatives. Implementation of various TDM measures may be feasible deeming the social, economic, political, and infrastructural positions. However, the situation in developing countries is quite different i.e. automobile growth rate is very high, motorcycle accounts major share of traffic and modal share, transit facilities are not up to mark and traveller's education and awareness are also key issues. The car users may account less than 10% of modal share and only high to upper middle income people can afford to use it. In other words, currently travellers belonging to car-oriented group are not so high; however, it might increases in next few years if proper attention is not given to improve transit facilities, and control automobile ownership and usage. Therefore, the focus points of TDM measures in developing countries are; how to keep existing transit users and target potential users or how to restrict existing transit users from owning and using a car and motorcycle, and motorcycle users from owning and using a car and attract them towards public transport and other sustainable travel alternatives to private vehicle. Targeting only car users may not result significant change in travel behaviour; however, imposition of fiscal restrictions on car use can generate some revenues that can be used for infrastructure improvement and development especially transit facilities. In addition, early imposition of fiscal restrictions on car and motorcycle ownership and usage may restrict the potential owners and users of these vehicles. However, these situations may be different in different cities of developing countries depending upon their socio-economic and transportation infrastructure characteristics.

2.3. IMPLEMENTATION CASES OF TDM MEASURES IN DEVELOPED AND DEVELOPING COUNTRIES

Different researches have mentioned the mechanism of implementation of different measures. Garling and Schuitema (2007) report that it is very important to promote such

policies, which should reduce advantage of car use and increase benefits of public transport usage. Kuwahara (2007) utilized the fundamental economic principles underlying congestion charging to model the impacts of offering the travellers *alternatives modes of travel, alternatives times of departures,* as well as no travel option as functions of *travel times, reliability, trip quality,* and *cost*. According to Stewart (2007), the road users charges should reflect the amount of externalities caused by the individuals or alternatively, charges should be adjusted in order to optimized the network and obtain equal marginal costs for each route. Maruyama and Sumalee (2007) present an analysis and assessment of two charging structures, *area licensing schemes* and *cordon-based systems* on their social welfare benefit and equity impact. They suggest that a simple system that is easy to understand by the users would be more preferably by both the public and the authorities. Bonsall *et al* (2007) believe that people appear to prefer simple pricing structures to complex structures. Wichiensin *et al.* (2007) consider the trade-off between the impacts of congestion charging on the individual drivers and the performance of the rest of the transport system. Road pricing is traditionally acknowledged by economics as a first-best solution or benchmark for containing externalities and optimizing traffic flow (Verhoef, 1996). An expert interview based study in Saudi Arabia depicts that tele-working, e-government, electronic shopping, congestion and parking pricing, increased fuel pricing, preferential treatment of HOVs, and light rail transit might be the potential TDM measures (Rahman and Al-Ahmadi, 2010). A study in Jakarta by Prayudyanto *et al* (2011) reveal that public transport is the basic key for change of travel behaviour in developing countries, but should be supported with parking restraint and road pricing. Combined measurers have larger impact on car use reduction compared to individual measure, and reduction mainly accompanied by means of trip chaining and changing travel mode (Eriksson *et al.* 2010). Level of effectiveness of implementation of TDM strategy is influenced by level of public acceptance, level of coerciveness, level of combination of strategies, level of target group of a TDM policy, and level of promotion and education for the implementation of the strategy (Pkusumantoro *et al.* 2009).

Various TDM measures were implemented in cities of developed and developing countries. Area licensing scheme (ALS) was implemented in 1975 in Singapore in order to manage the increased travel demand. With the implementation of ALS in Singapore traffic reduced by 45%, traffic speed increased by 20% and accidents fell by 25% (UNCHS, 1995). In 1998, ALS was transformed into electronic road pricing (ERP). The main reason behind success of Singapore pricing scheme is the strong and efficient enforcement. In addition to ERP, a measure of vehicle quota system (VQS) was implemented in 1990 in order to control vehicle ownership and proved as effective measures in alleviating traffic congestion (Foo, 1998). Similarly, in 2003, congestion charging scheme was implemented in central London using a flat fare system. Congestion charging in London has reduced traffic congestion significantly, and generates substantial revenues that are used for the improvement of public transport (Litman, 2004-2011). Parking management in Auckland reduced vehicle trips 8-18% and the level of drive alone around 2-5% (Auckland regional council, 2000). Table 2-3 elaborates the merits and demerits of implemented TDM measures in both developed and developing countries. Few TDM measures were implemented in Jakarta and Bangkok, but did not result significant change in travel behaviour because of implementation and enforcement issues as presented in table 2-3. Short term measures during some special events as Olympic Games in Beijing and Seoul the implemented measures produced significant results in terms of managing and reducing the traffic congestion.

Table 2-3: Scope and implementation cases of TDM measures in developed and developing countries and related issues

Scope of TDM measures in Developed Countries		**Scope of TDM measures in Developing Countries**	
Developed infrastructure and demand is increasing at slow rate (population growth rate is low and vehicle ownership has reached or is approaching to stage of saturation)- (Dargay & Gately, 1999), Have good public transportation infrastructure Main focus is to manage demand or influence behaviour of car users Political leadership is matured and have will to implement different policies Have strong institutional and financial resources Both long and short term programs and policy measures are feasible Measures have been implemented in some cities as presented below		Infrastructure is in developing stage. Urban population and vehicle growth rate is high Status symbol, inefficient public transport, low ownership and usage cost of automobile Main focus is on road infrastructure development in order to meet the increased demand Land use and development issues, and public transportation is in developing stage Institutional, technical and financial resources are insufficient Political constraints in implementation, and issue of public acceptability/acceptance Absence of traffic rules and regulations as well as their enforcement Some TDM measures have been implemented but gain low public acceptance	
City and measures	**Merits/ demerits**	**City and measures**	**Merits/ demerits**
London Congestion Charges, 2003, A flat fee system, easy to implement	Increase in travel speed and reduction in travel time Decline in automobile traffic Revenue collection for infrastructure improvement More use of public transport Increase in economic activity and productivity Public acceptance has grown and demanding in other cities Flat fee and type of vehicle does not matter No consideration of time of day i.e. Peak vs. off peak hours Charges should be based on distance and emission levels	**Jakarta** Rule (3 in 1 policy) Pricing & taxes Parking management Mode substitution Packaged TDM measures (staggered working hour and park-n-ride) (Kanda *et al.* 2005)	Common use of modes (ridesharing) Change in trip frequency to city centre Increase in mode shift from private to public transport Application of parking tariff is effective in influencing behaviour of traveller Low level of public acceptance due to enforcement issues Integration among different transit modes did not consider No attention towards control of vehicle ownership, and traffic education measures
Singapore Area Licensing Scheme in 1975 & Electronic Road Pricing (ERP) in 1998, Vehicle quota system (VQS) in 1990	Reduction in vehicle ownership growth by VQS Flexible rates for different time of the day and types of vehicles Increase in speed and reduction in traffic volume ERP is more efficient, flexible, reliable and equitable as compared to ALS but high initial cost Environmental aspects did not consider Need to consider all major roads within the city periphery	**Bangkok** Public transport improvements (rail transit, and bus rapid transit) HOVs lane Car pooling	Due to land use issues, transit developments did not affect the travel behaviour of car users significantly Implementation of high occupancy vehicle lanes resulted in traffic congestion due to enforcement issues
Stockholm Congestion charging, 2006-2007	First trial and then fully implementation Political influence Increase in reduction in traffic volume Exemption of alternative fuel vehicle in 2008 increased the sales of such vehicles (Borjesson *et al.* 2012)	**Beijing** Short term TDM Strategies during 2008 Olympics (based on even & odd registration number)	Better public acceptance Combined strategies are more effective Morning peak hour need more attention during important events (He *et al.* 2009)
Seoul , car use restriction during 1998 Olympics Congestion pricing for 2 routes, 1996 (cars < 2 occupants)		**Kuala Lumpur** Car pooling strategy	Low level of public acceptance due to social and religious factors (AB Rahman, 1993)
Greater Vancouver Trip reduction services Parking management Conversion of fix automobile costs to variable Road pricing	Energy conservation Decrease in environmental impacts Increase in ridesharing and mode substitution Reduction in vehicle miles travelled Increase in use of non-motorized modes Need to control the growth of vehicle ownership as in case of Singapore by putting some measures		

2.4. FACTORS INFLUENCING THE PUBLIC ACCEPTABILITY, AND EFFECTIVENESS OF TDM MEASURES

In different studies, push measures like road pricing and parking charges perceived low acceptability from public compared to pull measures such as public transport improvement (Thorpe *et al.* 2000; Schlag *et al.* 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 acceptance level of TDM strategies will be high if socio-economic and travel characteristics of road users consider properly (Pradono *et al.* 2009). The provision and improvements of public transport facilities are critical to the success and acceptability of congestion charging. High level of inherent public acceptance for improving public transport is confirmed relative to restrained based measures such as road pricing, parking charges and zone-access control, however, the combination of improved public transport and road user charging is considered as the most effective in reducing the use of private car (Thorpe *et al.* 2000). Many studies have shown different factors to be important in the acceptability of specific TDM measures e.g. pro-environmental behaviour, problem awareness, individual freedom in mode choice, personal and social norm, situational factors, value orientation and environmental beliefs (Eriksson *et al.* 2006; Schade and Schlag, 2003; Steg, 2003; Stern *et al.* 1995 & 1999). Table 2-3 presents the results of various studies regarding factors influencing the individual travel behaviour, acceptability and effectiveness of various TDM measures in both developed and developing countries. It is believed that lifestyles, status, and travel attitudes are important elements in changing travel behaviour and travel pattern (Beirao and Cabral, 2007; Steg, 2005; Bin and Dowlatabadi, 2005; Hildebrand, 2003; Tranter and Whitelegg, 1994). Cao and Mokhtarian (2005a, b) state that travel related measures are likely to be affected by individual's travel attitudes, personality, and lifestyles. However, different lifestyles and attitudes may affect the consideration of each strategy differently (Anable, 2005; Hildebrand, 2003). Moreover, mode choice behaviour or simply travel behaviour is affected with infrastructural and instrumental factors i.e. traveller's perception regarding the different modes of transport. Studies provide the evidence of various factors that are responsible for preferring one mode to others. Such studies also give the reasons for not using public transport, and tells the important service attributes for making effective improvement in public transport modes.

Generally, convenience, speed, comfort, and flexibility are well known arguments in favour of car (Anable, 2005; Hagman, 2003). Service quality of public transport modes is considered as an important element of users travel demand, and evaluation of service quality remains a challenging and important research area with practical implications for service providers (Hensher *et al.* 2003, 1998). It is still uncertain that whether public transport improvements will able to make modal shift or not, and if so, then what should be the level of service quality attributes in order to satisfy the needs of all segments of travel market. Under these circumstances, it is essential to evaluate the service quality in order to identify the potential strengths and weaknesses of public transport systems. This can provides clues to public transport operators and management in the process of enhancing user satisfaction and increase market value.

Table 2-4: Factors influencing the public acceptability and effectiveness of TDM measures in developed and developing countries

Developed countries		Developing countries	
TDM measure	**Factors**	**TDM measure**	**Factors**
Social marketing campaigns Public transport improvements Taxes on fuel	Personal norm Freedom aspects in travelling and problem awareness Moral obligations (personal norm) and perceived fairness in travelling (Eriksson *et al.* 2006)	Public transport improvements Car/van pooling Ride sharing (e.g. school and office transport) Increase in/ imposition of road tax or toll Parking restraints Peak period dispersion (staggered working and school hours)	Gender, income, occupation, car usage Sex, income, occupation, car usage Sex, income, education, occupation, car ownership, car and motorcycle usage Income, occupation, car usage, bus usage Income, education, occupation, car usage Sex, income, occupation, car usage (Bhattacharjee *et al.* 1997)
Application of social marketing policies to a specific population segments for switching towards sustainability travel market	Individual's lifestyle, and attitudes as determinants of sustainable mobility behaviour, and market segmentation based on these determinants (Prillwitz and Stewart, 2011)		
Traffic education and awareness campaigns Social marketing campaigns	Used to influence individual's attitudes, norms, and intentions, and have significant implications in changing attitudes, norms, awareness and travel behaviour (Bamberg *et al.* 2007 and 2011)		
Mode switching behaviour	Socio-demographic factors have little impact on the behaviour of the different segments of travel market, and attitudes largely dominate over personal characteristics. Instrumental, situational, psychological aspect of behaviour (Anable, 2005)	Communicative and marketing measures	Used to increase acceptance of coercive measures in Thailand, but did not find promising results (Choocharukul *et al.* 2006)
Acceptance of car use reduction using communicative or mobility management measures Expected car use reduction in response to TDM measures	Attitudinal aspects of private car and public transport i.e. symbolic/ affective, instrumental and social orderliness (Choocharukul *et al.* 2006) Pro-environmental orientation, problem awareness, personal norm (Eriksson *et al.* 2006) Internal motivational factors such as norm, perceived impact of measure (Eriksson *et al.* 2010)	Public transport improvements Student car pooling Workers car sharing Campus transportation	Gender, education, occupation, income and vehicle ownership Gender, vehicle ownership Gender, education, occupation income and vehicle ownership Gender, income and vehicle ownership (Pradono *et al.* 2009)

<table>
<tr><th colspan="2">Developed countries</th><th colspan="2">Developing countries</th></tr>
<tr><td>Reduction of ecological impact caused by mobility behaviour i.e. use of private motorized modes and the travelled distance (In three large cities of Germany)</td><td>Socio-demographic and psychological variables are the strongest predicators whereas infrastructural variables are the minor. The effective design of intervention programs to reduce the ecological impacts of mobility behaviour requires knowledge about the determinants of mobility related ecological impact.
(Hunecke et al. 2007)</td><td>Acceptance of car use reduction using communicative or mobility management (MM) measures</td><td>Attitudinal aspects of private car and public transport i.e. symbolic/ affective, instrumental and social orderliness but implications are still unsure (Choocharukul et al. 2006)</td></tr>
<tr><td rowspan="2">Prohibiting car traffic in city centre (Cambridge)
Road pricing (Singapore)- (Foo, 1997,2000)
Individual marketing (Perth, Australia)-</td><td rowspan="2">Socio-demographic (household income, car ownership), environmental concern related to traffic, auto-accessibility, problem awareness and beliefs concerning the traffic related consequences have impact on attitudes towards TDM measures (Loukopoulos et al. 2005)</td><td>Car pooling in Kuala Lumpur</td><td>Social and religious factors (AB Rahman, 1993)</td></tr>
<tr><td>Preferences or intention to use transit services</td><td>Auto-oriented and transit oriented lifestyles and attitudes results different impact on mode choice behaviour (Okamura et al. 2011)</td></tr>
<tr><td rowspan="2">Travel maintaining/ increasing get a better car or fuel-efficient car, change departure time, and adapt flexitime.
Travel reducing
Compressed working hour, change of mode, tele-working
Major location/lifestyle change
job or home location, start home based work, retire or stop working</td><td rowspan="2">Amount of travel, subjective assessments, desires and affinities with respect to travel, individual travel attitudes, personality, lifestyles and prior experiences are also likely to affect the effectiveness of travel related strategies. Socio-economic and demographic features may exhibit distribution effects with respect to the options that individual consider.
(Cao and Mokhtarian, 2005a,b)</td><td colspan="2">Developed countries</td></tr>
<tr><td>In two cities of UK (Newcastle, & Cambridge)
Public transport improvement
Road user charges
Parking charges
Zone access control</td><td>Frequency of private car use, pattern of private vehicle ownership and mode dependency in each city
“guaranteeing” a preferred allocation of the revenues
(Thorpe et al. 2000)</td></tr>
<tr><td>Stockholm congestion charging (2006-2007)</td><td>Objective and subjective effects of traffic system as well as general and environmental attitudes formed the basis of the strong public support (Borjesson et al. 2012)</td><td>Public transport improvement</td><td>Individual characteristics and lifestyle, type of journey, perceived service performance of transport modes, and situational variables (Beirao and Cabral, 2007)</td></tr>
</table>

However, developing accurate and valid measures of service quality is a complex task, since it deals with perceptions and attitudes. Both operators and authorities need to understand well how public evaluate the service quality. Service providers need to know the most important attributes of service quality that are perceived by current and potential users. For example, researchers have shown that travel time and schedule reliability is a decisive factor (Bates *et al.* 2001; Hensher *et al.* 2003). Similarly, attributes as frequency and comfort are also highly valued by commuters, and being key elements of consumer satisfaction (Hensher *et al.* 2003). Travel time and travel cost (fare) also found to have negative impact on users and non-users satisfaction (Githui *et al.* 2010; Hensher *et al.* 2003). Some other attributes e.g. information, driver behaviour, and physical conditions of vehicle also have some meaningful influence on consumer perceptions and satisfaction (Friman and Garling 2001). Fellesson and Friman (2008) identified the satisfaction dimensions of public transport i.e. comfort, staff, and safety.

Unrestricted availability of automobile also tends to influence the people activity patterns and mode choice behaviour (Badland and Schofield, 2008). Travel cost of car use relative to public transport and the quality of car travel are also major reasons of preferring car over public transport (Van-Exel *et al.* 2011). Previous studies (Van and Fujii, 2006; Steg and Vlek, 2005; Steg, 2005; Choocharukul *et al.* 2006) classify the attitudinal factors towards private car and public transport into three categories i.e. symbolic/ affective, instrumental, and social orderliness. These studies explore the significant implications of these factors in reduction of car use in developed countries whereas implications for developing countries are still unsure (Choocharukul *et al.* 2006). People's intentions to use public transport are also influenced by individual characteristics and situational factors (Steg, 2005) and perceived service performance of each transport mode (Beirao and Cabral, 2007). Therefore, it is vital to diagnose the traveller's perceptions regarding image of different private and public transport modes for effective policymaking.

2.5. SIGNIFICANCE OF MOBILITY MANAGEMENT (MM) MEASURES

Mobility Management (MM) is a transportation demand management policy that applies soft measures to reduce car use and promote sustainable transportation modes, such as public transport and bicycles (Jones, 2003, Fujii, 2004). MM tries to encourage people to change from car use to sustainable transportation modes voluntarily by using communication approach (Taniguchi *et al.* 2005). Garling *et al.* (2002) propose a theoretical basis for effective voluntary measure of reducing or changing private car use following the self-regulation theory of Carver and Scheier (1998) as shown in figure 2-1. The theory of planned behaviour (TPB) (Ajzen, 1991), has been used by Bamberg (2006) for the same purpose. In these theories psychological processes are assumed to play an important mediating role in explain the behavioural consequences. Attitudes change, goal setting, and formation of intention tend to play important role in long-term effects of MM measures.

Psychological methods of mobility management such as individualized communication, organizational travel plan, travel feed back program (TFP) or travel blending (Thogersen, 2007) are characterized by their focus on mediating psychological process as shown in figure 2-2. Different techniques are used with respect to different objectives i.e. whether they motivate travel behaviour change, whether they provide customized information, whether they request setting goals of changing travel behaviour, and whether they request plans for how to change travel behaviour (Garling *et al.* 2002). In different cities of developed countries, MM measures were used to influence individual travel behaviour. Fujii and Taniguchi (2005) reviewed the effectiveness of ten travel

feedback programs (TFPs) implemented in different cities (Sapporo, Osaka, Suita, Kanazawa, Izumi, etc.) of Japan, and they found that the TFPs reduced CO_2 emission by about 19% and car use by about 12%, while increasing the use of public transport by about 50%. In addition, the effectiveness of TFPs increases when participants are asked to make behavioural plans to change their travel behaviour. TFPs are varied with respect to locations, techniques for travel behavioural change, procedures and communication media. Similarly, Taniguchi *et al.* (2005) used MM measures for promotion of bus service called "Ring-Ring-Bus" in the city of Obihiro and study results verify that MM measures are effective in the promotion of bus service. Individual marketing programs have produced a reduction in car use up to 14% in South Perth. TFPs implemented in UK cities such as Gloucester, Bristol, and Nottingham has reduced car use by 7 to 15% in urban areas and by 2% in rural areas.

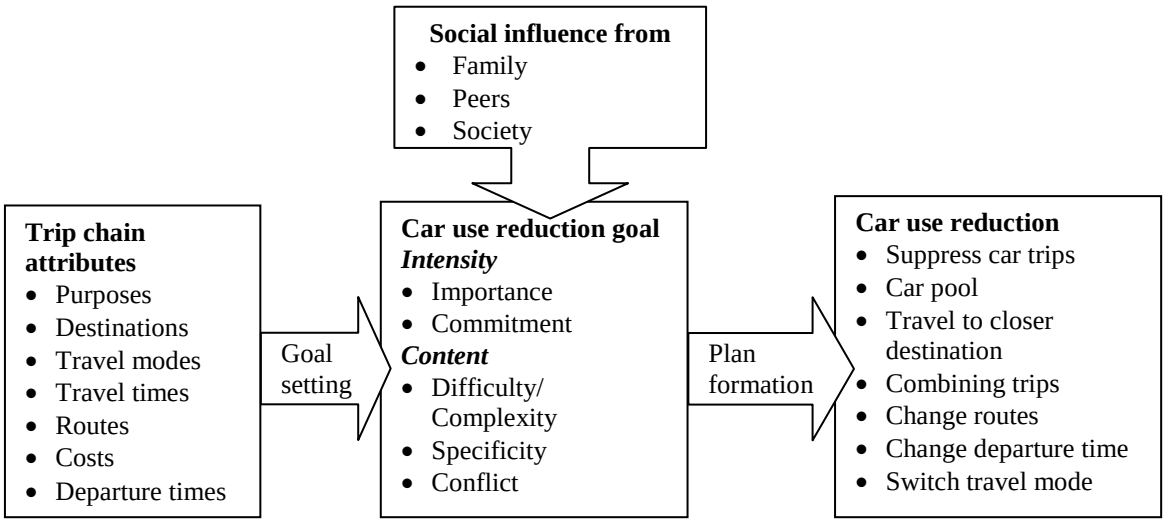


Figure 2-1: A conceptualization of behavioural change

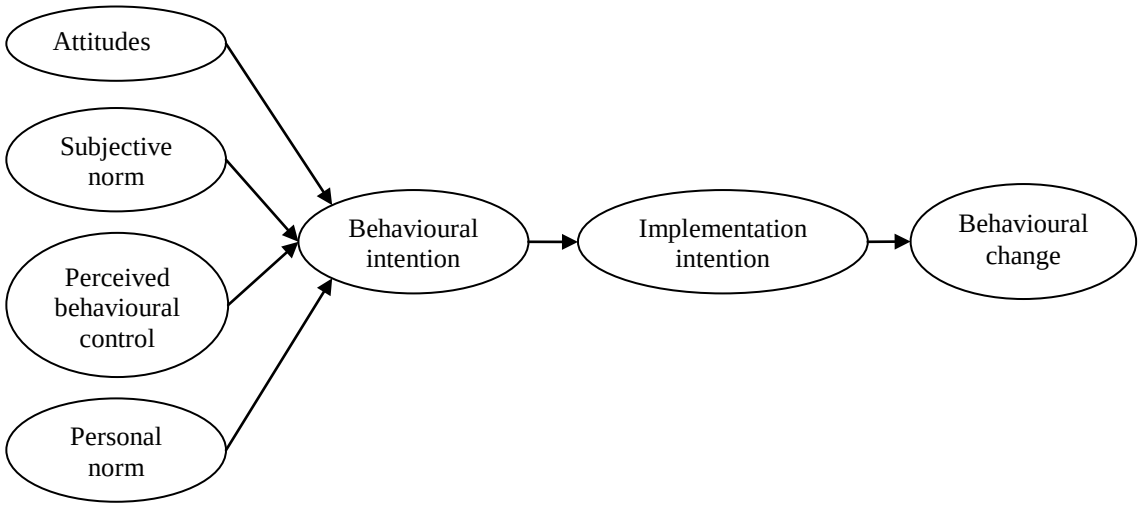


Figure 2-2: A model of the effects of individualized marketing on travel behaviour change

2.6. APPLICATION OF BEHAVIOURAL THEORIES IN TRANSPORTATION RESEARCH

Researchers in the field of transportation are widely using behavioural theories for evaluation of behavioural consequences of driving and travel behaviour. These theories include the Theory of Planned Behaviour (TPB), Norm-Activation Model (NAM), and Value-Belief-Norm (VBN) theory. Here, detail of only first two theories is given that were used in this research. The NAM developed by Schwartz (1977) and the TPB developed by Ajzen (1991).

2.6.1. The Theory of Planned Behaviour (TPB)

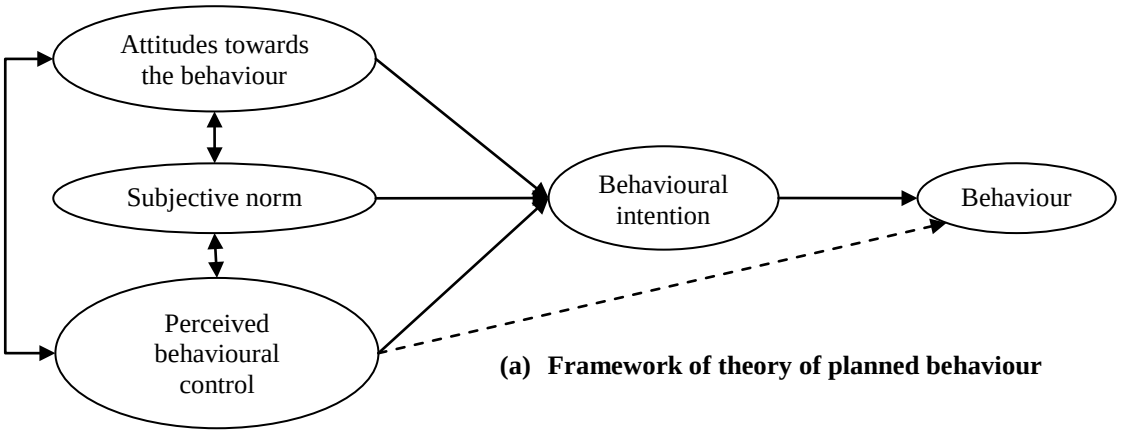
The TPB is an extension of the theory of reasoned action (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). According to this theory, travel behaviour is supported by rational evaluation of behavioural outcomes. The people's *attitudes towards the behaviour*, *their subjective norm*, and *their perceived behavioural control* determine their behaviour indirectly via their intentions. The sum of perceived positive and negative outcomes of the behaviour identifies the first factor of TPB i.e. '*attitude towards the behaviour*. '*Social or subjective norms'* are considered as second factor influencing behavioural intentions. The TPB also realizes the significance of various situational constraints, personal experience, and limitations on individual travel behaviour and adaptation process to a specific alternative. Therefore, '*perceived behavioural control (PBC)'* is the third factor in TPB, which means individual's ability to perform given behaviour. The *intention* is defined as a willingness to try to perform the behaviour and the *behaviour* refers to a well-defined action. The more positive a person's attitude and subjective norm is, and the greater their perceived behavioural control, the stronger is their intention to perform the behaviour. Finally, given enough actual control over the behaviour, people are expected to carry out their intention as soon as they have opportunity. For behaviours over which people have less control, it is also useful to consider PBC in addition to intention for prediction of behaviour. When people are realistic in their judgements of behaviour's difficulty, a measure of perceived behavioural control can contribute to the prediction of behaviour. Therefore, it is believed that PBC also has a direct impact on behaviour. A typical model of TPB is presented in figure 2-3(a).

The applications of TPB in studies regarding developing countries are not found or limited to issues of road safety; however, many researchers have applied the framework of this theory such as Warner and Aberg (2006) determine the driver's decision to speed; Nordfjaern *et al.* (2010) used to investigate driver attitudes and behaviour in rural and urban areas in Norway; Hunecke *et al.* (2007) determined ecological impact of mobility behaviour using the attitudes theory; Anable (2005) identified the travel behaviour segments using this theory and Cao and Mokhtarian (2005a,b) used the attitudinal concept to identify the determinants of individual travel behaviour. Similarly, Prillwitz and Barr (2011) evaluated the sustainable travel behaviour using the concepts of TPB. This theory has also been used extensively in relation to traffic safety (Parker *et al.* 1992; Aberg, 1993).

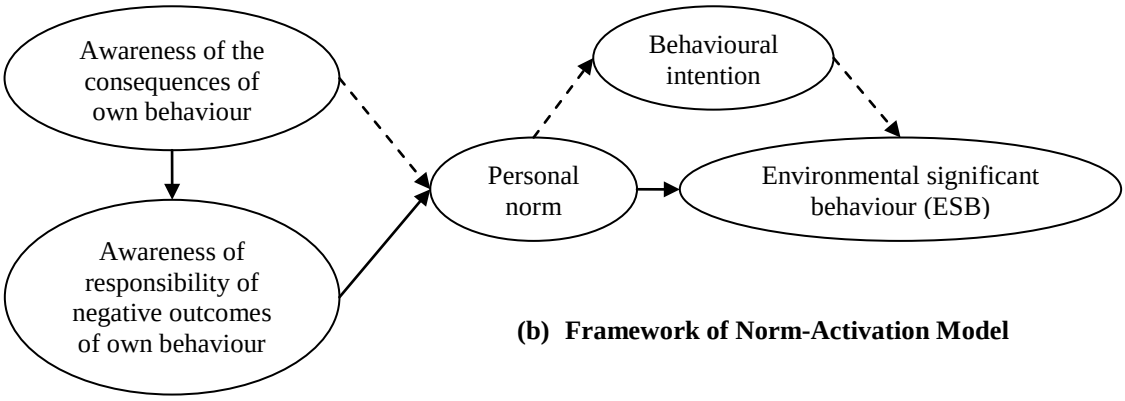
2.6.2. The Norm-Activation Model (NAM)

The NAM originally was developed to explain pro-social behaviours or environmental significant behaviour (ESB). Consequently, researches using this model conceptualize car use reduction as s behaviour primarily driven by pro-social motives (Eriksson *et al.* 2006). This concept as shown in figure 2-3(b) is based on the assumption

that a '*personal norm'* is the most important determinant of travel mode choice. A '*personal norm'* is defined as the felt moral obligation for bringing own behaviour in line with personal standards. The NAM assumes that the information as well as activation of personal norms is the result of interplay of cognitive, emotional, and social factors. '*Problem awareness (AC) and perceived responsibility (AR)'* are important cognitive preconditions for the development of *personal norm* (PN). Some researchers propose a mediator models (Steg *et al.* 2005; Stern, 2000; Stern and Dietz, 1994), in which they assume that AC has indirect effect on PN through AR, which in turn has an indirect effect on intentions and behaviour through PN. Other researchers argue that the relationship between PN and pro-social behaviour is moderated by AC and AR (Schultz and Zelezy, 1998; Hopper and Nielsen, 1991), that is, the relationship between PN and pro-social is believed to be especially strong among those who are highly aware of the consequences of not acting pro-socially and for those who feel highly responsible for the consequences of this behaviour. The findings of De Groot and Steg (2009) studies with a variety of pro-social intentions, including environmental significant intentions, strongly support the NAM as a mediator model. The NAM appeared to be successful in explaining various kinds of ESB, including energy conservation (Tyler *at al.* 1982) and willingness to pay for environmental protection and public goods (Guagnano, 2001; Guagnano *et al.* 1994).



(a) Framework of theory of planned behaviour



(b) Framework of Norm-Activation Model

Figure 2-3: Conceptual models of behavioural theories

Many researchers applied this concept to explain the behavioural consequences of car users travel behaviour. Stern *et al.* (1995, 1999) used this theory to explain the environment significant behaviour. Eriksson *et al.* (2006) applied this concept to evaluate acceptability of TDM measures and explained the importance of problem awareness,

personal norm, freedom, and fairness in travel behaviour. Steg and Vlek (1997) evaluated the role of problem awareness in willingness to change car use using this theory.

2.6.3. Joined applications of TPB and NAM in travel behaviour research

In some studies, joint-model of TPB and NAM was developed in order to explain environmental significant behaviour and attitudes towards soft policy measures (Bamberg *et al.* 2007 and 2011; Bamberg and Moser, 2007). In these studies, based on the assumption that motivation to perform behaviour is mixture of different motives, model proposed to combine both theoretical frameworks by introducing personal norm into the TPB as an additional independent predictor of intention. A brief description of combined approach is given in figure 2-2. Abrahamse *et al.* (2009) used the framework of both theories to examine the factors influencing the car use for commuting and the intention to reduce it. This study also tries to develop a joint-structural-model (JSM) of TPB and NAM same as developed by previous researches by introducing three additional independent variables of lifestyles, travel attitudes, and intentions.

2.7. DEFINITIONS OF VARIOUS TERMINOLOGIES USED IN THIS STUDY

Lifestyle: it is a way of living of individual, families, and societies, which they visible in coping with their physical, psychological, social, and economic environments on day-to-day basis. Lifestyle is expressed in both work and leisure behaviour patterns and in activities, attitudes, interests, opinions, values, and allocation of income. It also reflects people's self-image and personality; the way they see themselves and believe, they are seen by the others. Moreover, it is combination of motivations, needs, and wants and is influenced by factors such as culture, family, and social class. The analysis of traveller lifestyles is an important factor in determining how different travellers make their decisions for travelling.

Personality traits: these are the habitual patterns and qualities of behaviour of any individual as expressed by physical and mental activities and attitudes. Personality traits are the unique set of characteristics and qualities that only one possesses. While many people might have similar personality traits, each person combines these traits in a different way, to create one unique, irreplaceable assembly traits that make up their individual personality.

Attitude: An attitude can be defined as a positive or negative evaluation of people, objects, event, activities, ideas, or just about anything in your environment. Attitude may refer to the distinct concept of mood. Many measurements and scales are used to examine attitudes. Attitudes can be difficult to measure because measurement is arbitrary, and attitudes are ultimately a hypothetical construct that cannot be observed directly.

Control beliefs: an individual's beliefs about the presence of factors that may facilitate or hinder performance of the behaviour (Ajzen, 2001). The concept of perceived behavioural control (PBC) is conceptually related to self-efficacy.

Subjective norm (SN) is an individual's perception about the particular behaviour, which is influenced by judgment of significant others (parents, spouse, friends, teachers).

Social norm (SN): Social norms are group-held beliefs about how members should behave in a given context. Socialists describe norms as informal understandings that govern society's behaviours. Social norms also allow assessing what behaviours the group deems important to its existence.

Behavioural belief: it is an individual's belief about consequences of particular behaviour. The concept is based on the subjective probability that the behaviour will produce a given outcome.

Attitude toward behaviour: an individual's positive or negative evaluation of self-performance of the particular behaviour. It is determined by the total set of accessible behavioural beliefs linking the behaviour to various outcomes and other attributes.

Behavioural intention: it is an indication of an individual's readiness to perform a given behaviour. It is assumed an immediate antecedent of behaviour (Ajzen, 2002b). It is based on attitude toward the behaviour, subjective norm, and perceived behavioural control, with each predictor weighted for its importance in relation to the behaviour.

Personal norm (PN): it is the individual feeling of moral obligation to refrain from doing some negative behaviour or tend to do environmental significant behaviour.

Awareness of consequences (AC): generally, it is individual awareness about the negative outcomes of own behaviour.

Ascription of responsibility or sense of responsibility (AR): it is the feeling of responsibility of negative outcomes of own behaviour.

Behaviour: it is an individual's observable response in a given situation with respect to a given target. Ajzen said behaviour is a function of compatible intentions and perceptions of behavioural control in that perceived behavioural control is expected to moderate the effect of intention on behaviour, such that a favourable intention produces the behaviour only when perceived behavioural control is strong.

Chapter 3

RESEARCH METHODOLOGY AND CHARACTERISTICS OF STUDY AREA

This chapter elaborates the steps of research methodology and characteristics of study area. Figure 3-1 presents the schematic diagram of research methodology. Reviewed literature regarding scope of study was presented in chapter 2. This chapter elaborates the selection criteria of case study city in developing countries and appropriate TDM measures for evaluation, characteristics of study area, methods of questionnaire designs and surveys, and analysis and modelling techniques. This research started with evaluation of potential of existing transportation infrastructure, people's general lifestyles and attitudes, and potential TDM measures that were presented individually to the respondents, and related results are presented in chapter 4 and 5. In chapter 6 and 7, study focused in detail on individual's attitudes, norms, and control beliefs in relation to private and public transportation modes. In these chapters, the selected measures were presented to public with different scenarios. The TDM policies were developed and presented in chapter 8. Chapter 9 summarizes the key study findings, implications, and recommendations for future research.

3.1. SELECTION CRITERIA OF CASE STUDY CITY IN DEVELOPING COUNTRIES

Extensive literature was reviewed regarding transportation problems and their possible solutions in different cities of developed and developing countries e.g. Singapore, London, Bangkok, Lahore, Karachi, Faisalabad, Jakarta, Beijing, Kuala Lumpur, Tokyo, Seoul, Bombay, etc. Few cities in developing countries were found with the implementation of some specific TDM measures as described in chapter 2, but their applications and success are very limited. Countries are divided into developed or developing according to their Gross National Income (GNI) per capita per year. Countries with a GNI of US$ 11,905 and less in 2010 are defined as developing countries (World Bank, 2012). A comparison was made for socio-economic and transportation infrastructure characteristics between few cities in developing countries for selection of case study city such as Lahore, Karachi, Faisalabad, Jakarta, Bangkok, Kuala Lumpur, Beijing, Colombo, Tashkent, Bombay, Manila, Hanoi, Curitiba, Dhaka, etc. The main points considered in the selection of city are listed below.

- Country gross domestic product (GDP) per capita below or around 5000 US$ (at purchasing power parity (PPP) as per 2010-2011) or low income and lower middle income countries with gross national income (GNI) per capita ≤ 4035 US$ (World Bank, 2012)
- A city with nature of metropolitan area (usually an area with 100,000 or more people) and lies in large size cites with population more than 5.0 million
- A city entering into range of megacities (population of 10 million or more)
- A city with extensive road infrastructure and severe transportation problems
- A city having significant role in social and economic development of a country

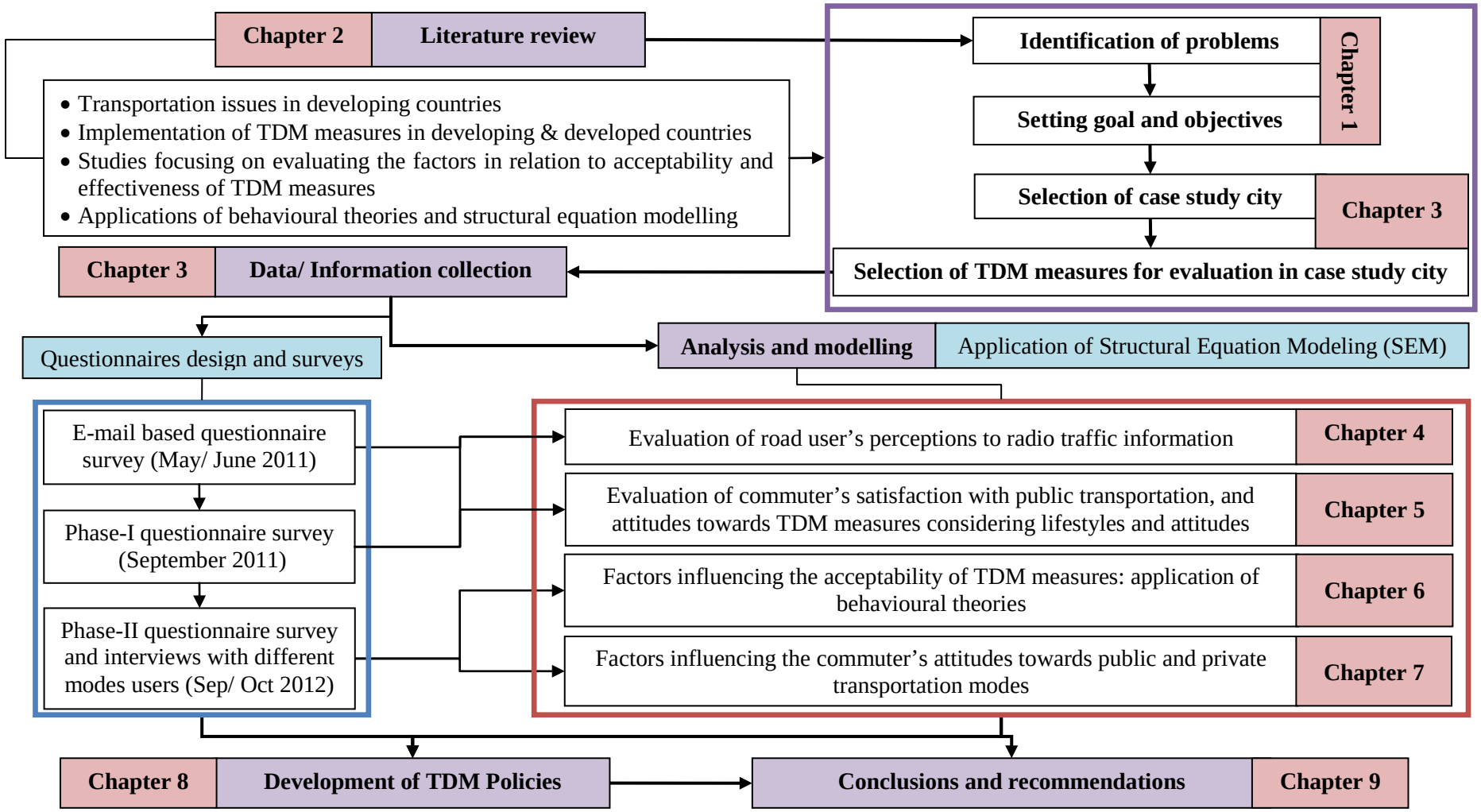


Figure 3-1: Schematic flow diagram of research methodology

- A city facing high trend of automobile ownership and needs immediate measures for control of travel demand and reduction of automobile dependency
- A city with feasibility of implementation of various TDM measure
- Well awareness about local and transportation conditions
- A city with limited studies focusing on travel behaviour research
- Easiness of getting required information and data
    - Feasibility of conducting questionnaire survey and interviews
    - Literacy level of respondents
    - Possibility of conducing email based or online survey
    - Communication with the concerned authorities/ officials

Seeking the above-mentioned guidelines, Lahore was selected as case study city. The strongest elements behind selection were well awareness of local conditions and feasibility of conducting questionnaire surveys and interviews.

3.2. CHARACTERISTICS OF STUDY AREA: LAHORE CITY

3.2.1. Pattern of population growth and urban land development

Lahore is the second largest city of Pakistan, and cultural and educational capital of the country. It has grown along the historical route of Grand Truck (GT) road linking Central Asia with the sub-continent. Figure 3-2 shows the map of Lahore Metropolitan Area (LMA), which covers an area of 1792 Km^2 and has population approximately 8.65 million (JICA, 2012) as shown in figure 3-3(a). The recent JICA (2012) study reports that current 8.65 million population of Lahore has 1.8 million households, employed residents is 2.7 million, average household income per month is 20,000 PKR, average income per capita per month is 3,500 PKR, household car ownership 18% and household motorcycle ownership 43%. Lahore can be classified into three population density zones: high-density inner zone, medium density intermediate zone and low-density outer zone. Population is mostly concentrated around the old city area in a concentric fashion. Population density varies almost from 450 persons per hectare in the inner zone to 50 persons per hectare in the outer zone. Major developments occurred along major arterial roads i.e. linear development. Around 70% of population is living within radius of 7-8 km from city centre. The regulations are still very weak in controlling the land use and development despite of several development plans. Lahore has high potential of transit development considering the number of trips generated due to high-density development in inner zone. However, population density in Lahore is still considerably lower than similar cities in Asia (JICA, 2012). It is concentrated with many educational institutions and medical facilities as well as surrounded by industrial zones. There is high trend of migration of people to Lahore city for education, jobs as well as to enjoy better living facilities. Age groups 15-19 and 20-24 year form the peak for both male and female as shown in figure 3-3(b). The literacy rate of Pakistan and Lahore is around 55% (CIA, 2009) and 74% (GoP, 2012) respectively.

3.2.2. Vehicle ownership growth and modal share

The vehicle growth rate has reached to 17% per year between 2004 and 2008 in Lahore, increasing the traffic congestion on the roads. Now-a-days, Lahore residents are showing a high trend for motorcycles ownership, which were tremendously increased by 483% or 136 units per 1,000 residents in 2008. Figure 3-4(a) shows the pattern of vehicle ownership growth in Lahore. The main reasons of increase in automobile ownership are

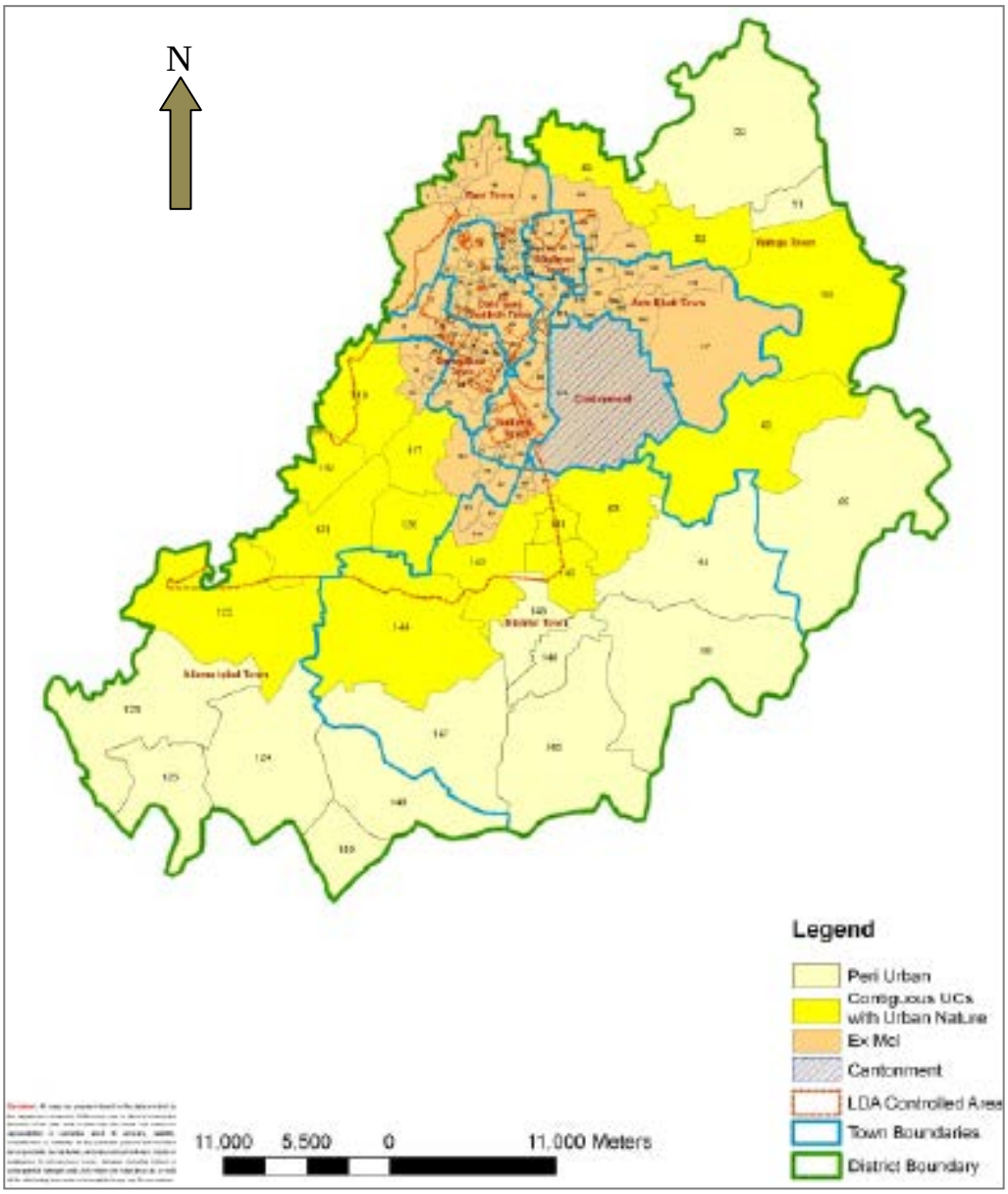
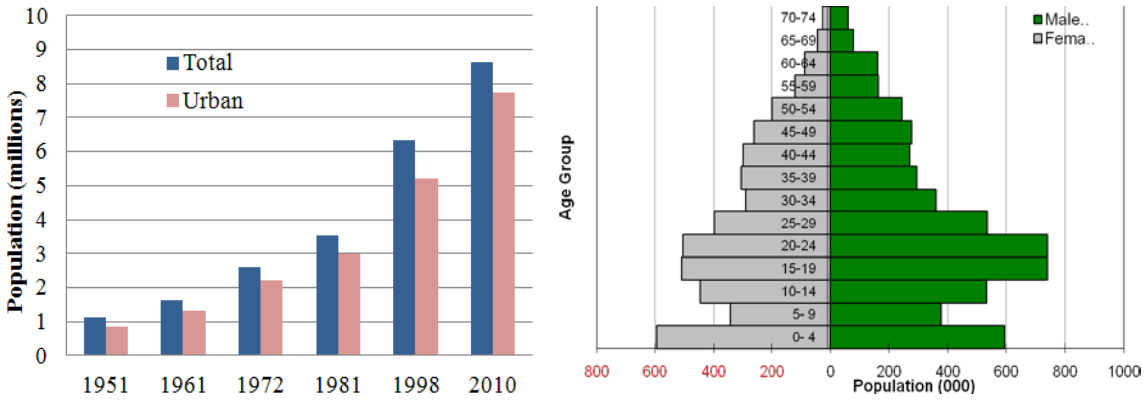


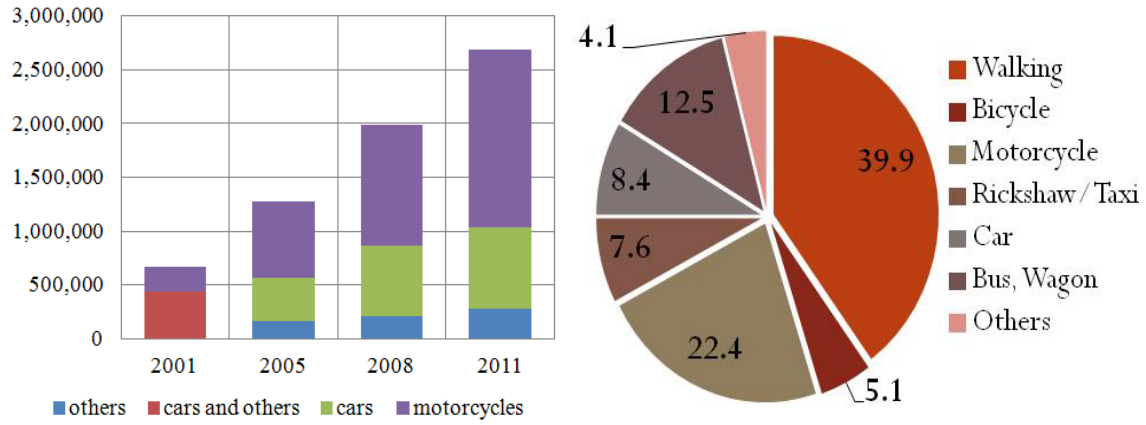
Figure 3-2: Map of Lahore city
(Source: Urban Unit and Faiza and Jamal, 2009)



(a) Total and urban population growth (b) Male and female age structure (JICA, 2012)

Figure 3-3: Population growth and age structure of residents in Lahore

banking leasing policy of government, status symbol, changing lifestyles, increase in income, low ownership, and usage cost. Government policy to import used cars from developed countries (e.g. Japan) also affect the car ownership and its usage. Figure 3-4 (b) shows the modal share of Lahore city. The share of car ownership is more in low to medium density areas, whereas share of motorcycle ownership is more in medium to high-density areas. The trip rate of male and female in Lahore is 1.32 and 0.53 respectively (JICA, 2012). According to recent JICA study regarding Lahore urban transport master plan walking is major mode of travelling regardless the type of trip or trip distance. Generally, it has been observed that local people do not like to walk or use bicycle even for shorter trip. Almost more than 13.5 million motorized trips are generated in Lahore (Urban Unit, 2007). People prefer to use motorcycle even for shorter trip, and use it as a family mode. Motorcycle almost accounts for 45 % of road traffic (Urban Unit, 2010), whereas 22.4 % of modal share (JICA, 2012). The share of car is almost 9%, which is likely to be increased if attention is not given to improve public transport and impose measures to reduce usage of private vehicle. Use of motorcycle and car also threatens the safety of pedestrian and bicycle users.



(a) Vehicle ownership growth (source: GoP) (b) Modal share (Source: JICA, 2012)

Figure 3-4: Pattern of vehicle growth and modal share in Lahore

3.2.3. Overview of historical urban and transportation development plans

The Master Plan for Greater Lahore was prepared by the Housing and Physical Planning Department, Government of Punjab in 1966. In order to segregate the urban Lahore from surrounding towns a 24 km wide green belt was proposed. Construction of a ring road, a new road bridge on river Ravi, up grading of major roads, and provision of underground and multi-storey parking lots in the central area was proposed. A circular railway system was also proposed for commuting traffic. However, due to lack of development control, the city continued to grow linearly along radial routes, and the Greater Lahore Master Plan failed (Imran and Low, 2005, Hameed and Nadeem, 2006).

Lahore urban development and traffic study, 1980 (LUDTS) was conducted by Halcrow Fox UK, and it was the first attempt to plan the city growth, and prepare an integrated development and transportation infrastructure plan for the year 2000 with the help of World Bank. The study identified issues related to traffic characteristics, urban land and road infrastructure development, institutions, and public transportation operation and management. Other main proposals of this study was to construct the “Southern by Pass”, renamed as “Lahore Ring Road”. The “model urban transportation system” in Lahore was completed in 1980 with the financial and technical grant of the Volvo

International Development Corporation. As a result of this study, 350 Volvo buses were gifted by the Swedish Government to Lahore. However, after operation of couple of years, bus system in Lahore collapsed because of the organizational inefficiency of the government (Imran and Low, 2005, Hameed and Nadeem, 2006).

1991 comprehensive study on transportation system in Lahore was conducted by JICA consultants with the assistance of Lahore Development Authority (LDA) & Traffic Engineering and Planning Agency (TEPA). The study objectives were to formulate a transportation master plan for the study area for 2010, with intermediate action plans for year 2000, and to conduct feasibility study of selected mass transit system. Beside urban and road development plans, JICA proposed rail mass transit including the construction of the light rail transit (LRT). This project has four lines i.e. green line, blue line, orange and purple line (ADB, 2008). So far, this project did not implement due to some financial and political issues.

Lahore urban transportation master plan 2020-2030: This study was conducted in 2010-2011 by JICA for Government of Punjab with following objectives: to formulate an urban transportation master plan for the study area up to the year 2030 and action plan for the identified priority projects up to the year 2020, and to provide assistance to strengthen the institutional and administrative capacity of the Government of the Punjab. According to report, the total travel demand for public transport in 2030 would exceed 5 million. In this master plan, JICA has proposed major public transportation improvements, which include three lines of rail mass transit in spite of four lines as in 1991 master plan and Bus Rapid Transit (BRT) on four major arterials (JICA, 2012).

3.2.4. Structure of existing public transportation

The public transportation network in Lahore is currently under-developed, highly fragmented, inadequately managed, and inefficient. More than 800,000 passengers are using public transportation in Lahore where about 800 high occupancy buses only are operating by almost 13 private companies. There is a big gap between the demand and provision of an efficient and environment friendly public transportation. Currently, public transportation services are providing by many private bus operators i.e. Daewoo, Premier Bus Service, First Bus, Niazi, Malik, Baloch, and Futon (Chinese) etc. The urban bus operation is regulated through Lahore Transport Company (LTC), setup by the Government of Punjab in 2009. There are almost 53 planned routes for buses and 48 routes for wagons or minibuses along with the concentration of motorcycle rickshaws on various routes. Premier Bus Services, owned by the Beacon house Group, was started in 2003. It provides premium transportation services to the public of Lahore, with almost 250 buses running on exclusive routes. Daewoo Korean owned company operates four routes within the Lahore city and two suburban routes connect urban parts with two nearby districts i.e. Gujranwala and Sheikhupura. Daewoo bus service has almost 76 buses; they are air-conditioned and provide better comfort to the passengers. Other operators run their buses only on few routes. Figure 3-5 presents the picture of vehicles of various bus and Para-transit services. The Para-transit service comprises of wagons/ minibuses (15-20 seats), motorcycle rickshaw (qingqi), auto-rickshaw and taxi.

Due to rapid motorization and increase in traffic volume over the last two decades, the road network has become congested which increases travel delays and reduces bus travel speeds, implying a less competitive public transportation network, especially in the Central Business District where commercial and trading activities are concentrated. Current public transportation services are suffering greatly due to irregularity. Efficiency is acceptable on certain routes but reliability is poor, there is no scheduling at all. Many vehicles are operated without valid license, with an estimated 25% or more of wagons/

minibuses with no valid license (JICA, 2012). Many wagons and coasters drivers do not follow the authorized route, and sometimes do not complete the full route journey. The inefficiency of public-owned public transportation has led to the multiplication of illegal operation and forcing the private vehicle ownership even higher. User-friendly, economical, and affordable public transportation development is the first demand of most of the residents. Moreover, public transportation organizations in Lahore have a long history of deficiency in professional, administrative, and financial capacity to manage public transportation service. In the absence of human resources, coordination, research, and financial capacity of public transportation institutions, public transportation has now become fully the privilege of the private sector. The incomplete routes, high fares, fewer buses, gender discrimination, and even absence of buses in some places are common in the urban areas. Whole public transportation is grossly mismanaged with least objective of service provision, limited and inadequate condition of public transportation facilities.

(a) Air-con Daewoo Bus (b) Non-air-con bus (c) Air-con CNG bus (d) Para-transit (wagon)

(e) Suzuki service (f) Motorcycle rickshaw (g) auto-rickshaw (h) taxi

Figure 3-5: Existing public transportation modes in Lahore city @ 2011
(Source: Author)

3.2.5. Current demand management practices and related issues

At different stages, some conventional demand management measures were implemented in order to reduce transportation sector externalities and fulfil the needs of people belonging to different travel market segments.

Improvements in public transportation systems: Despite of several urban transportation master plans throughout the years, there is no significant development in urban public transportation sector until now. As stated earlier, Lahore city has significant potential for mass transit development, which is also support by recent JICA study report. Figure 3-6 shows the time for urban rail development in major cities of different regions in the world. According to this comparison, the time for urban rail mass transit development has reached considering the population growth and economic development pattern. In 2011, Chinese Futon Company, Ankai and some other private operators have started operation with CNG buses on various routes under the supervision of LTC, but shortage of CNG in the country is an issue in operation of these buses. Other improvements include introduction of separate buses for females on few routes with

limited capacity and construction of Bus Rapid Transit (BRT) Line with the co-operation of Turkish company, which was inaugurated in February 2013. BRT line consists of almost 27 kilometres long road track from Gajumata to Shahadra, out of this track 8.5 km is elevated. Articulated buses have been provided for metro bus service (MBS) and travel time for the 27 km is almost one hour. It has 29 bus stations and e-ticketing and intelligent transportation system is part of the MBS. However, some people are still unsure about the success of this system due to political, operational, financial, and local issues as well as service quality level of other modes. Moreover, there is still big gap between demand and supply despite these improvements and development of BRT line.

Transportation service for educational institutions: Government of Punjab has made policy regarding provision of transport service for students in educational institutions (including schools, colleges, and universities). Currently, most of the public sector universities and colleges provide transport for their students with sufficient capacity whereas this trend is very limited in private sector. Most of the students especially female prefer to use such service because it is safe, secure, economical, reliable, and punctual than public transportation modes. However, some students do not use because its schedule is fixed and they need to do some other activities on the way e.g. teaching in a tuition centre. The provision of such transport service has significant role in reducing the automobile dependency in the period of rapid increase in car and motorcycle ownership and weak public transportation system. If this service will not available instead of using public transportation, students may prefer to use motorcycle or even car if they have as use of motorcycle is very popular among young people, and female students may pick up/drop off by their family members due to security, religious and social issues.

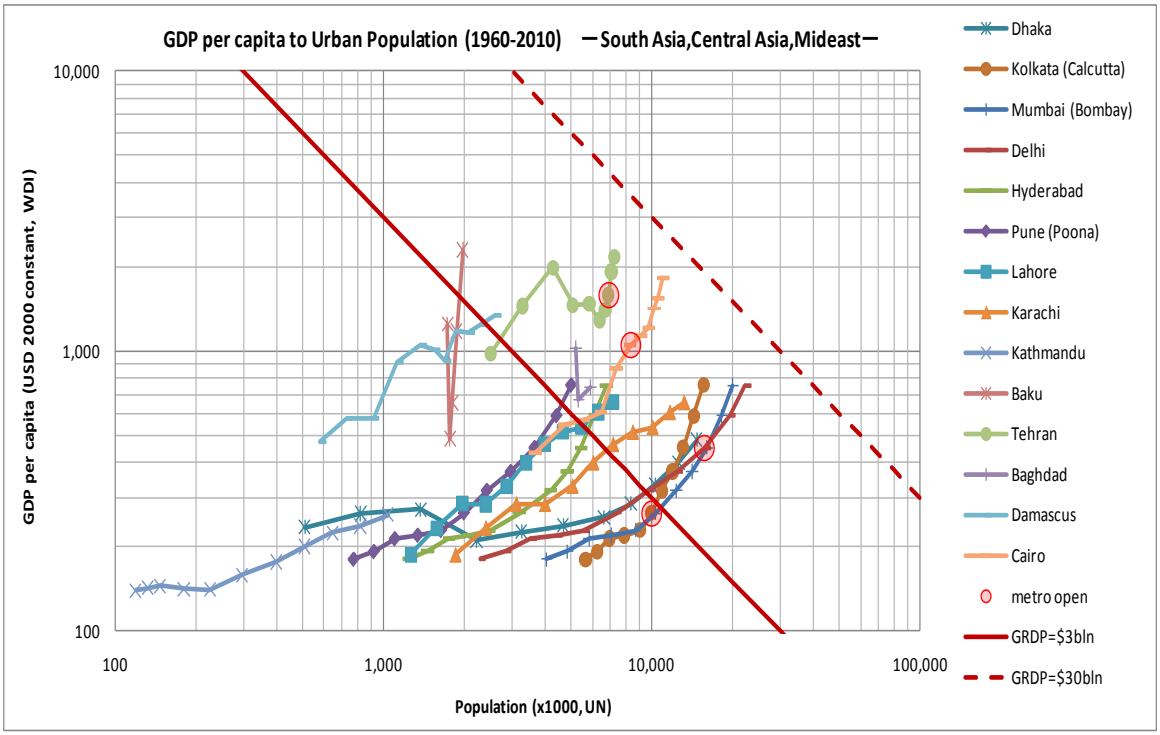


Figure 3-6: Timing of urban rail development in major cities of South Asia, Central Asia and Middle East in Relation to GDP per Capita and Population
(Source: World Urbanization Prospect 2009 (UN), GDP per capita: WDI2008; JICA final report on Lahore urban transport master plan 2011)

It has been observed that traffic congestion mainly occurs during the school timing in both the morning and afternoon. Parents prefer to pick up and drop off their children at school on their private vehicle especially middle and high-income people because they feel that public transport is not good, safe and secure for their children. Uneven society and education system are also reasons for such trend of use of private vehicle. In some cases, group of some parents living in a particular locality hire a van, wagon, or rickshaw for pick up / drop off their children at school on monthly basis. However, this practice also tends to result congestion during school timing due to limited capacity of these vehicles and insufficient parking facilities at school place. Therefore, there is need to make an effective policy regarding provision of transport service at school both in private and government schools for solution of transportation problems. However, due to certain limitations, this research does not evaluate the potential of this policy, and recommends it for future studies.

Transportation service for employees: Some organizations, institutions, and industries provide transport service for their employees or workers but with limited capacity. Only low-income people and non-private vehicle owners use such facility because it is cheaper, reliable, punctual, secure, and comfortable. However, private vehicle owners prefer to use their private transport. Therefore, this study aims to investigate the potential of such service in reducing the use of private vehicle.

Traffic information and awareness programs: It is believed that education and awareness of travellers can solve transportation problems in an effective manner by psychologically influencing the driving and travelling behaviour of road users. For this purpose, Lahore traffic police has started road and street traffic awareness programs (RASTA) and its details are given in chapter 4.

Restriction on entry of rickshaws and heavy trucks: Entry of two-stroke auto-rickshaw is restricted in high profile urban areas (e.g. army controlled cantonment area) for environmental reasons. Similarly, entry of Qingqi is restricted in CBD and some other areas. Heavy freight trucks are allowed to enter in urban areas only at night. These restrictions argue that entry of certain vehicles can be restricted if policy makers have will for this otherwise not. For example, entry of auto transport can be restricted in highly congested areas by providing a good quality public transport.

Park and Ride facility: Around two years back one parking plaza was constructed in order to start park-n-ride service. This parking facility has unique approach and concept. The main objective of providing park-n-ride service is to control illegal parking in some commercial areas where parking is limited. For this purpose, special coasters have been provided with this parking facility for riding instead of integrating it with public transportation modes.

3.3. SELECTION OF TDM MEASURES FOR STUDY IN LAHORE

Various TDM measures were selected for study in the context of Lahore seeking the socio-economic characteristics, local transportation conditions and problems, automobile ownership and usage cost, gradual change of travel behaviour, feasibility of implementation and anticipated effectiveness in changing travel behaviour and mitigating the transportation and environmental problems. Measures were selected from following perspectives as to maximize the efficiency of existing infrastructure through advance traffic information (route and departure time choices) and awareness approaches, provide good public transport to existing transit users and better travel alternatives to private transport (mode substitution and efficient use of private vehicle), reduction in private vehicle trips, and minimize the advantage of using private vehicle. Other factors include short term versus long-term objectives of reducing the traffic congestion. In addition, as

any measures cannot be effective alone in its objective; therefore, integration among or mix of various measures is required e.g. impositions of pull measures in combination with push measures. Despite of several classification schemes as described in previous chapter, the selected TDM measures were categorized into three categories in this study i.e. psychological or soft, pull, and push measures as mentioned in table 3-1. This classification scheme was used because of difficulty in recognizing between soft and hard measures in some cases due to social, institutional, and political aspects.

3.3.1. Psychological or behavioural or soft measures

Education and attitudes of travellers and drivers is a key issue in Lahore. Most of the drivers are un-educated or have low education especially drivers of taxi, rickshaw and truck, and drive disorderly which results traffic congestion and accidents. Everybody on roads looks in hurry and wants to reach at destination as early as possible. It has been observed that either people do not follow traffic rules properly intentionally or unintentionally, even some people feel proud in disobeying the traffic rules. It is believed that education and awareness of travellers can solve transportation problems in effective manner. Therefore, people's intention to participate in traffic education and awareness programs has been evaluated in this study. In addition, advance traffic information tools were employed in many countries in order to reduce the traffic congestion and increase efficiency of transportation system. These advance traffic information system can provide latest information to the travellers about traffic conditions on road network (e.g. traffic situation is normal, slow or congested on specific road) for making effective individual trip planning. Based on provided traffic information, road users are expected to change their route, departure time, and even mode under specific circumstances. These traffic information sources tend to enhance the reliability and efficiency of road network. In this study, people's perceptions were asked regarding provision of advance traffic information and potential of existing radio traffic information service in making individual trip choices effective. In addition, it is supposed that such advance traffic information sources can be used for creating awareness among public about transportation problems and their sustainable solutions.

3.3.2. Pull measures

Table 3-1 presents the selected pull measures, which include public transportation improvements, provision of office based transportation service for employees from organizations and institutions, and tele-working (home-based work). These measures tend to provide travel alternatives to private vehicle, and reduce private vehicle trips. As stated earlier, current public transportation in Lahore is under-developed and inefficient, and has huge potential of improvement and further development considering the number of trips generated due to high-density development in inner zone and modal share of public transportation. Currently, public transportation is mainly transport of poor people, and private vehicle owners prefer to use their vehicle. As people are moving towards motorcycle and car due to inefficiency and under-development of public transportation; therefore, improvements would help to keep the existing users and to attract potential user's i.e. private modes users. This research will attempt to identify the important features of public transport that need to consider in making improvements.

At present, some organizations and institutions are providing transportation service for their employees but with limited capacity and mainly low to middle income people use it. High-income people prefer their private vehicle for commuting trips. Therefore, inclusion of this measure will help in evaluating its future potential in reducing the private

vehicle dependency. Some organizations also provide home-based work/ projects to skilled workers such as engineers/ planners. Trend of doing part-time work or business with full time job forces the people to use private vehicle; because, with public transportation it is difficult to manage office timing and travel schedule. Provision of tele-working opportunities can help in eliminating the additional part time work trip, and making people little independent from private vehicle. Moreover, such working opportunities can be useful for educated female who cannot do job due to family and social issues. Therefore, this study tends to explore the potential of tele-working programs from above perspectives in Lahore city.

3.3.3. Push measures

The low vehicle registration taxes, subsidized fuels, free parking, or low parking fees at office and commercial sites and other vehicle related taxes tend to increase automobile ownership as well as usage. On the other hand, expensive public transportation tends to push people towards private transport. Residents of Lahore believe that travel cost of motorcycle is almost half of public transport. It is believed that push measures have more potential of reducing car use compared to pull measures; however, they gain low acceptance from the public and less favour from planners and politicians for implementation. Various fiscal measures were selected seeking the potential to increase the usage cost of private vehicle, and enhance the acceptability and effectiveness of pull measures. Private vehicle users will not shift to improved public transport and other alternatives unless or until the travel cost of private vehicle increases significantly in comparison to public transport. Moreover, imposition of such fiscal measures will generate the revenues that can be used to improve road infrastructure and transit facilities. Land use policies are considered as powerful tools in shaping the metropolitan areas and generating travel demand for different modes. Such policies can significant contribute in changing the travel behaviour or making promotion from private vehicle to public transport and other travel alternatives. In this context, strategies of parking restrictions were included in this study such as limited parking at destination and far parking from destination in rapid transit oriented area. Car entry restriction policy was also selected for evaluation in combination with improved public transportation. It was supposed that restricting the car entry in rapid transit supported area can help in improving the acceptance and effectiveness of public transport improvement measure. The details of these measures are given in table 3-1.

Table 3-1: Description of selected TDM measures

Category	TDM measures	Policy description in questionnaires
Psychological or soft measures	Advance traffic information	• Evaluation of road users perceptions to traffic radio information (traffic radio questionnaire) • Provision of advanced traffic information for relieving traffic congestion (questionnaire-I)
	Mass education and awareness programs	Intentions to participate in traffic education and awareness programs (questionnaire-I)
Pull measures (Mode substitution and trip reduction measures)	Public transport improvements	• Intentions to use better mode of public transportation (questionnaire-I) • Willingness to use improved public transportation, and pay for the improvement/ development (questionnaire-II) • Intentions to use improved public transportation in response to double travel cost of car use (questionnaire-II)

Category	TDM measures	Policy description in questionnaires
		• Desired service quality level of improved public transport of all modes users, and intentions to use it under fiscal restrictions on use of private vehicle (Detailed interviews)
	Office based transport service for employees (*defined as a transport service provided by organizations/ institutions for employees*) or workplace travel plans	• Intentions to use such service if it is initiated (questionnaire-I) • Willingness to support the government policy, and use this service (questionnaire-II) • Intention to use this service in response to double travel cost of car use (questionnaire-II) • Intentions to use this service with mentioning merits and demerits (Detailed interviews)
	Tele-working (online working or home-based work opportunities)	Intentions to do such work if there is an opportunity (questionnaire-I)
	Car pooling or ride sharing (questionnaire-II)	Intention to share car with friends/ colleagues in response to double travel cost of car use
Push measures (economic and land use measures)	Parking restrictions • Parking charges • Limited and far parking at destination (questionnaire-I & II)	• Support to increase parking charges at office sites for reduction of traffic congestion (questionnaire-I) • Response and behavioural intentions to increase in parking charges for doubling the travel cost of car use (questionnaire-II) • Intentions to use improved public transport with gradual increase in parking charges both on car and motorcycle (Detailed interviews)
	Increase in overall travel cost of car and motorcycle usage	• Intentions to use improved public transport with gradual increase in overall travel cost of car and motorcycle usage from 100 to 400% by increasing parking charges, fuel taxes, and other vehicle related taxes (Detailed interviews)
	Taxes on fuel	• Support to increase carbon tax on gasoline for reduction of air pollution (questionnaire-I) • Response and behavioural intentions to increase in taxes on gasoline for doubling the travel cost of car use (questionnaire-II) • Intentions to use improved public transport with gradual increase in fuel price by increasing taxes (Detailed interviews)
	Road tax or toll schemes on urban roads	• Willingness to pay road taxes or toll in order to improve traffic conditions in the city (questionnaire-I) • Response and behavioural intentions to increase in toll or road taxes for doubling the travel cost of car use (questionnaire-II) • Intentions to use improved public transport with gradual increase in road tax or toll on car use (Detailed interviews)
	Annual vehicle registration taxes	• Response and behavioural intentions to increase in taxes for doubling the travel cost of car use (questionnaire-II) • Intentions to use improved public transport with gradual increase or imposition of annual vehicle registration taxes (Detailed interviews)
	Car entry restriction in public transport area	Preference to use improved public transportation under this restriction (questionnaire-II)

3.4. DATA COLLECTION METHODS

The findings of this study are based on results of questionnaire surveys and detailed interviews in Lahore city. One email based and two field questionnaire surveys were conducted to get required data in order to achieve objectives of this research. Initially, potential of existing transportation infrastructure was evaluated in email based survey and field survey of phase-I. In this context, public satisfaction with existing public transportation and perceptions to radio traffic information was considered. Phase-I survey attempted to evaluate the people's general lifestyles, travel attitudes and preferences, and eight TDM measures that were presented individually to the respondents. This survey also formed the basics and feasibility of designing and conducting the Phase-II survey. In phase-II survey, individual's attitudes, norms, control beliefs and lifestyles were selected specific to travel modes and under the framework of behavioural theories. The selected TDM measures in second survey were presented to the respondents with different scenarios and conditions. The Likert Scales were used in evaluation of most of the questionnaire items in both surveys. The Likert Scale is an ordinal psychometric measurement of attitudes, beliefs, and opinions. In each question, a statement is presented in which a respondent must indicate a degree of agreement or disagreement in a multiple choice type format. This scale has following merits in conducting questionnaire survey: most universal method for survey collection; therefore, they are easily understood, responses are easily quantifiable and subjective to computation of some mathematical analysis, it does not force the participant to take a stand on a particular topic and provides the flexibility to respondents in answering the questions (it does not require the participant to provide a simple and concrete yes or no answer), responses are very easy to code when accumulating data since a single number represents the participant's response. Likert surveys are also quick, efficient and inexpensive methods for data collection.

Detailed interviews were conducted with different modes users in addition to three questionnaire surveys. These interviews provide the detailed picture of factors responsible in the use of different modes, and scenarios of different policy measures. The details of these questionnaires design and related surveys are given in next subsection.

3.4.1. Questionnaire design and survey relating to traffic radio

This questionnaire was related to evaluation of effectiveness of radio traffic information service in Lahore. The details of related questionnaire items are given in appendix A. It consists of following parts: personal, driving, and travel information i.e. gender, occupation, education, vehicle ownership, usual daily travel mode and frequency of usual daily trip, availability of alternative route, and arrival time flexibility in morning trip, driving frequency, etc; perceptions to traffic radio and satisfaction with service quality attributes of traffic radio and intentions to use traffic radio in future in case of service improvements. This questionnaire was designed to target both commuters including all mode users and professional drivers such as rickshaw, taxi and truck drivers. Road users were asked to report listening propensity of traffic radio and response behaviour to the perceived information and detail of questions is given in part 2 of appendix A-I and A-II. In part 2.2 of this questionnaire, various attributes of service quality were selected such as reliability of information, efficiency (effectiveness of traffic radio in creating awareness), accessibility of traffic information (easiness in getting required frequency and access to sources of listening such as mobile, radio, etc.), broadcasting frequency of latest information, geographical coverage (coverage of all important routes), the details of information, and satisfaction with overall performance of traffic radio. At the end, future preference to listen traffic radio in case of service

improvement was asked. The respondents were asked about travel time reduction after following radio information i.e. in case of change of route, departure time, and mode.

This survey was conducted in two phases. In first phase, survey was conducted through emails from university students, faculty members, technical staff, and employees of various organizations. Questionnaire was sent to target respondents as email attachment. The file was password protected and respondents needed to send back questionnaire after filling as email attachment. Total 56 samples were obtained out of 120 i.e. a response rate of 46.67%. In second phase, field survey was conducted by visiting Lahore city with commuters and professional drivers i.e. taxi, truck, and rickshaw drivers. Different places were selected to conduct this survey. These places include railway station, airport, urban public transportation, and intercity public transportation bus terminals. Interview and self-completion approaches were used considering the literacy level of respondents. In the second phase, a field survey was conducted with the help of graduate students of university. All the respondents were interviewed by visiting different places such as bus terminals, railway station, airport, and commercial areas. A very low response rate was observed from road users in sharing personal information and perceptions about traffic radio. Number of samples of field survey consists of 54 rickshaw drivers, 42 taxi drivers, 30 truck drivers, and 66 commuters (car, motorcycle, auto-rickshaw, and public transport users).

3.4.2. Phase-I questionnaire design and survey

The objectives of this survey were to judge the people literacy level and ability in answering the different questionnaire items as guidelines and feasibility to design items of phase-II questionnaire. This questionnaire was designed to know lifestyles, attitudes, and intentions of people living in different parts of Lahore city. As stated earlier, population density in different parts of Lahore varies significantly, and socio-economic aspects are also different between those parts; therefore, lifestyles and attitudes may vary among people living in different parts of city. It was consisted of four parts and details of each part are given in appendix B. The questionnaire was designed to target current car users, and potential car users (current non-car users). The reasons of including opinion of potential car users are the rapid increase in car and motorcycle ownership and their usage during the last decade due to low ownership and usage cost. Therefore, it was assumed to evaluate perceptions and preferences of potential car users in advance towards TDM measures. In part 1, frequency of travel with different modes and for different trip purposes was asked using following scale i.e. Never, a few times a year, a few times a month, 1-2 times a week, 3-4 times a week and 5-7 times a week.

In part 2, people's perceptions were asked to lifestyles, attitudes and behavioural intentions and selected TDM measures. All the stated questions of part two were evaluated using a four-point Likert scale (i.e. strongly disagree, somewhat disagree, somewhat agree, strongly agree). Sense of different social and personal values, ways of thinking, living preferences, trip making preferences, and travel attitudes towards different modes under various situations were the main motives in selection of various lifestyles, attitudes, and behavioural intentions. The questionnaire included statements relating to lifestyles such as desire to have a car, personality, and change of lifestyle with change of income and living preferences. The people's current travel attitudes were included such as ride sharing with family members and friends and trend to use non-motorized modes for short trip. The questionnaire also included statements regarding people's attitudes and preferences in their social life and travelling i.e. interaction with unknown people, behaviour change, priority to cheaper fare and shorter travel time. Two statements were included on route and mode choice behaviour in case of traffic

congestion. Some questions were included relating to use of public transport under certain conditions such as high parking charges, absence of parking, and trip length 3-5 km. Two statements were asked on intention 'to do not use or reduce use' of private vehicle in future for reduction of traffic congestion and negative effects on the environment. Eight TDM strategies were selected in part two seeking the feasibility of consideration and implementation in Lahore. The respondents were asked to show opinion on each strategy considering whether they support a specific strategy in reducing the traffic congestion or not. In case of fuel taxes, carbon tax only on gasoline was included considering the social impacts of tax on other fuels because increase in tax on diesel may results increase in prices of living goods. Public willingness was asked to pay road taxes to improve traffic conditions and support to increase parking charges. The measures of intentions to do online or tele-work, and participate in organization and institution based transport services were selected keeping in view current practice and their future potential. The willingness was asked to participate in traffic education and awareness programs, and use public transport in case of better mode. The respondent's opinion was asked on provision of advance traffic information in order to relieve traffic congestion in the city.

Part 3 included various attributes of Para-transit and Daewoo bus service were selected, and evaluated using a four point Likert scale i.e. not satisfied (1), less satisfied (2), satisfied (3) and totally satisfied (4). These modes were selected for evaluation seeking their existing and future potential in public transportation system of Lahore city. In last part, personal information were asked i.e. gender, age, income, education, occupation, vehicle ownership, possessing driving license, and drive vehicle or not. Four point Likert scales were chosen for evaluation of questions in part 2 and 3. It was assumed that four point scales are appropriate considering a questionnaire survey in developing country. Therefore, trade-off was made between reliability of data and easiness of respondents in answering the ordinal scale questions. The purpose of questionnaire was stated at the start of sheet, and guidelines were also provided at the start of each part in order to ensure the reliability of data.

Survey was conducted with the help of university students. Six students were selected from bachelor class (B-4) and fresh graduates of BSc Transportation Engineering. Among six students, three students already had experience of conducing survey during their internship program and after graduation for some organizations. However, all students were trained for the purpose and contents of questionnaire items, and methods for conducting the survey. Thirteen locations were selected in Lahore city, and assigned to each members of survey team. One-day pilot survey was conducted before actual survey for clarity of sentences and checking easiness of respondents in filling or answering the different questionnaire items. Seeking the objectives of survey, respondents were selected randomly at each location. Both interviews and self-completion approaches were used in conducting the survey. It was assured to conduct survey through interviews from those respondents who are uneducated or literacy level was low. The respondents were selected randomly at selected locations and total 1,000 questionnaires were used. Some people were reluctant in sharing personal information and even opinions on other stated questions, because they were unsure about the right usage of provided information. Only 668 filled questionnaires were obtained which represented 66.8% return rate. Almost 300 samples were not returned by respondents even after two weeks as most of the questionnaires were distributed at various locations, and some questionnaire forms were wasted during the survey. Later on 37 samples were discarded from collected 668 due to incomplete information and double answers on some questions. Therefore, results of only 631 samples were used in analysis and modelling.

3.4.3. Phase-II questionnaire design and survey

Seeking the objectives of phase-II survey a comprehensive questionnaire was designed consisting of six parts and details of each part are given in appendix C. The main target groups of this questionnaire design were university students, faculty members, technical and administrative staff, and employees of other private and government organizations. Therefore, different lifestyles, attitudes, norms, beliefs and intentions were selected seeking the potential target groups of travel market. Part one and six include personal and trip information of respondents respectively.

Second part of questionnaire consisted of questions regarding lifestyles, travel attitudes, attitudes towards public transport, social or subjective norms, perceived behavioural control over public transport, awareness of consequences of car use, sense of responsibility of the negative consequences of car use, echo-friendly personal norm, and perceived feasibility of protecting environment. Most of the statements in this part were designed deeming the theoretical background of behavioural theories i.e. theory of planned behaviour (TPB) and norm activation model (NAM), and the potential target groups of travel market. The respondents were asked to show their level of agreement with each statement on an ordinal scale. A six point ordinal scale (strongly disagree, disagree, somewhat disagree, somewhat agree, agree, and strongly agree) was selected considering the limitations of behavioural theories, data reliability, respondent's simplicity in filling and a questionnaire survey in a developing country.

Third part of questionnaire consisted of questions relating to evaluation of selected policy measures, and evaluated using the same six point ordinal scale as in part two. The respondents were requested to show their level of agreement with the government policy regarding provision of office based transport service for employees from organizations and institutions considering reduction in traffic congestion, and air pollution. They also needed to show willingness to use this transport service. For public transport improvement strategy, respondents were asked to rate their willingness to use improved public transport, and pay taxes for the improvement of public transport considering the five scenarios i.e. for reduction in traffic congestion, for reduction in air pollution, for more reliable service than car, for less travel cost compared to car and for less travel time compared to car. For fiscal policy, respondents were asked to show their willingness to accept for policy of doubling the travel cost of car use by increasing the fuel taxes, parking charges, road taxes, and annual car registration taxes. They needed to show level of agreement with policy considering three conditions i.e. reduction in traffic congestion and air pollution, and if collected taxes/charges use to improve public transport. They also needed to report behavioural intentions in response to implementation of this policy considering five situations i.e. travel by car as usual, travel less by car, prefer to travel by improved public transport, travel by car but sharing travel cost with friends, and prefer to use available office/ campus transport. The respondents were communicated about the benefits associated with the implementation of fiscal policy i.e. reduction in congestion and air pollution will result decrease in travel time and cost, and health cost. For evaluation of three policy measures, only most appropriate scenarios were chosen due to limitations of questionnaire and conducting survey.

The structure of questionnaire items in part four was primarily based on Osgood's semantic differential technique with five point adjective scale. Semantic differential scales, developed by Osgood et al. (1957), provide the interval data that can be arranged in order and measured. Semantic differential scales measure a person's attitude toward concepts and are useful in situations with different age groups or cultures. This technique was used in this research because it has following advantages: easy to construct, easy for the respondent's to use, short and quick to administer, provides reliable quantitative data

and can correlate highly with score from Likert scales. Semantic differential has been applied to marketing, operations research, and personality measurement. The attitudes towards private car and public transport were measured by using beliefs in the form of pairs of opposite adjectives. These attitudinal attributes include expensive-cheap, uncomfortable-comfortable, slow-fast, inconvenient-convenient, unreliable-reliable, traditional-advanced, risky-safe, inelegant-elegant, public-personal, stressed-relaxed, noisy-calm, unrespectable-respectable, boring-exciting, unattractive-attractive, unhealthy-healthy, crowded-un-crowded, unfriendly-friendly, low social value-high social value, environmentally destructive-environmental friendly. Respondents were asked to show their preference to use public transport and private car under situational factors, mobility restrictions on car use, public transport incentives, and moral obligation in part five of questionnaire. All questions in this part were evaluated using five point scale i.e. absolutely use car, usually car but also accept public transport for sometimes, both car and public transport as per situation, usually public transport but not every time and absolutely use public transport. This part consisted of 18 conditional statements and against each condition respondents needed to show preference. Some mobility restrictions on car use were included such as limited parking space at destination, very far parking from destination, road tax and parking charges on car use, and car entry restrictions in public transport service area. Incentive measures were also included on use of public transport such as reliable service, direct access to many destinations, low travel cost as compare to car, and less travel time as compare to car. The respondents were asked to give their preference for public transport usage when they felt moral obligation for reduction of traffic congestion, air pollution, and preservation of natural resources by reducing car use. The respondents were requested to assume one car in house if currently they did not have. They needed to show preferences deeming the specifications of existing Daewoo bus service and improved public transport such as bus rapid transit (BRT) as presented at the start of this part. The specifications of improved public transport were selected considering the under-construction of BRT line and its future perspective in Lahore. The respondents also requested to select one mode from Daewoo bus and Bus rapid transit (BRT) when they selected non-car alternatives.

This survey was conducted in engineering university, and various private and civil organizations during September-October 2012. One main objective of this questionnaire survey was to target current and potential car users. Therefore, respondents who used car and had more potential of using in future were targeted in the university and other organizations. Purpose of conducting this questionnaire survey was stated at the start of questionnaire along with details of conducting authority. The filling guidelines were also mentioned at the start of each part. The respondents were selected randomly in selected organizations, and survey was conducted with the help of university graduate students. Initially, students were trained for the purpose and contents of questionnaire, and conducting methods of survey. One-day pilot survey was conducted before actual survey for clarity of sentences, and checking easiness of respondents in filling the questionnaire. Self-completion approach was used in conducting the survey. The questionnaires were distributed by visiting selected sites, and instructions were given to the respondents for the purpose and contents of questionnaire items, and filling procedure in order to ensure the reliability of data. Some respondents were reluctant in sharing personal information and opinions on other survey items during survey. Initially, respondents were requested to return the filled questionnaire after two week, and filled questionnaires were collected again with the help of survey team. Additional time of one week was given to those respondents who did not able to complete in the initial period. Moreover, regular meetings were conducted with survey team to assure the reliability of information, and

timely completion of survey. A total 500 questionnaires were used in the survey and only 372 samples were obtained, which represented a return rate of 74.4%. Eighteen samples were discarded due to incomplete information and double answers on ordinal scale questions. Therefore, results of only 354 samples were used in further analysis.

3.4.4. Design of interviews forms for different mode users

Detailed interviews were conducted with selected private car, auto-rickshaw, motorcycle, and public transport users to understand the travel attitudes towards existing travel modes, perceptions for the improvement of public transport, and behavioural intentions of private car and motorcycle users under fiscal restrictions. These interviews were conducted during September-October 2012 in different private and civil organizations/ institutions and details of questions are given in appendix D. Some interviewees were approached directly in first meeting, and in some cases, appointments were made first, and then interviews conducted. Only 42 samples were obtained including all groups due to busy schedule of employees, lengthy interviews and reluctance in sharing personal information. These interviews were conducted with employees and students because they were regular travellers and knew better about merits and demerits of transport modes. In addition, it was supposed to get proper time from employees for such lengthy interviews. The interviews generally took around 45-60 minutes depending on interviewee's understanding of questions and availability of time. Three separate interview forms were prepared for car and auto-rickshaw, motorcycle and auto-rickshaw, and public transport and non-motorized modes users. The common questions of these forms included the important factors in travelling, advantages and disadvantages in using existing mode, reasons of not using other modes, perceptions regarding desired service quality of improved public transport, preference to use improved public transport and office based transport service. All mode users were asked for what kind of public transport they want in Lahore, and what should be the qualities of that transport. If a public transport is provided according to their desired level whether they will use it or not, and if so, then what is extent of this? Similarly, intentions were asked to use office based transport service from their institutions and organizations, and if they use what are the merits and demerits of using it. In addition, intentions of auto users were asked towards private vehicle and improved public transport considering fiscal restrictions on the use of private vehicle. Public transport users were asked for their intentions to own car and motorcycle, and motorcycle users for intention to own car in future.

The behavioural intentions of car users were asked to fiscal measures. There were five fiscal policies and each policy had four levels i.e. (1) 100, 200, 300, 400% increase in overall travel cost of car use by increasing parking charges, road tax, fuel taxes, and vehicle registration taxes, (2) increase in parking charges, (3) increase in road tax or toll, (4) increase in fuel taxes, and (5) increase in annual car registration taxes. The increase in road tax and parking charges had following four levels 50, 75, 100, 150 PKR, whereas fuel taxes 20, 30, 40, 50 PKR. The intentions to parking charges and road tax were asked on one-commuting trip in one day. For vehicle registration taxes, the selected levels included 50, 100, 150, and 200% increase in annual registration taxes. These levels were chosen seeking the gradual increase in travel cost, and considering the current practice of parking charges, road tax, and price of gasoline and vehicle registration taxes. Car users needed to select one from three alternatives at each level of each policy i.e. 'continue to use car same as before (1), sometimes car and sometimes improved public transport (2), and totally shift to improved public transport (3). Like car users, motorcycle users were also asked for behavioural intentions to fiscal measures. These measures included increase in overall travel cost of motorcycle usage from 100 to 400%, parking charges

and fuel taxes. The levels of parking charges and increase in taxes on gasoline included 20, 30, 40, and 50 PKR. These four levels were chosen considering the current parking fee structure and gasoline price. Again, motorcycle users needed to select one from three alternatives i.e. 'continue to use motorcycle same as before (1), sometimes motorcycle and sometimes improved public transport (2), and totally shift to improved public transport (3).

3.5. APPLICATION OF STRUCTURAL EQUATION MODELING (SEM)

Collected data through questionnaire surveys was analyzed for evaluation of influencing factors using structural equation modelling procedures. It is relatively a new methodology for multivariate analysis and its roots can be found in the 1970s. Researchers in the field of psychology, sociology, biological sciences, and market research are frequently applying this methodology for analysis of data and making inferences. Its application in travel behaviour research was started from 1880s. Structural equation modelling (SEM) is a statistical methodology that takes a confirmatory approach (i.e. hypothesis testing) to the analysis of structural theory bearing on some phenomenon. Typically, this theory represents "***causal***" processes that generate observations on multiple variables (Bentler, 1988). The term structural equation modelling tells two important aspects of the procedure: (a) that the causal processes under study are represented by a series of structural equations (i.e. regressions) and (b) that these structural relations can be modelled pictorially to enable a clear conceptualization of the theory. The hypothesized model can then be tested statistically in a simultaneous analysis of the entire system of variables to determine the extent to which it is consistent with the data. Estimation of SEM is performed using the con-variance analysis method. If goodness-of-fit is adequate, the model argues for the plausibility of postulated relations among variables; if it is inadequate, the tenability of such model is rejected (Byrne, 2010).

3.5.1. Description of SEM model specification

SEM models provide an efficient and convenient way of describing the latent structure underlying a set of observed variables. These models expressed either ***diagrammatically*** (path diagram) or ***mathematically*** via a set of equations, and such models explain how the observed and latent variables are related to one another. Figure 3-7 presents a general SEM model, which demarcated into different components. Generally, a statistical model is postulated based on knowledge of the related theory, on empirical research, or on some combination of both. Once the model is specified, plausibility of model is tested based on sample data that comprise all observed variables in the model. The primary task in this model-testing is to find the goodness-of-fit between the hypothesized model and the sample data. Generally, the structure of a hypothesized model imposes on the sample data, and then tests how well the observed data fit this restricted structure. It is very difficult to get a perfect fit between the observed data and the hypothesized model, therefore; there will necessarily be a difference between the two and this difference is termed as residual (Byrne, 2010). Therefore, the model model-fitting process can be written as follows in equation 3.1:

$$\text{Data} = \text{model} + \text{residual} \qquad (3.1)$$

Where; ***data*** represent score measurements related to the observed variables as derived from person's response comprising the sample, ***model*** represents the hypothesized structure linking the observed variables to the latent variables, and in some

models, linking particular latent variables to one another, ***residual*** denotes the discrepancy between the hypothesized model and the observed data.

Latent versus observed variables: In the field of behavioural science, researchers are often interested in studying theoretical constructs that cannot be observed directly. These extracted phenomena are termed as ***latent variables or factors*** and represented by circle or ellipse as ξ_1, η_1, η_2, in figure 3-7. Because latent variables are not observed directly, it follows that they cannot be measured directly. Thus, the researcher must operationally define the latent variable of interest in terms of behaviour believed to represent it. As a result, the unobserved variable is linked to one that is observable, thereby making its measurement possible. Assessment of the behaviour, then, constitutes the direct measurement of an observed variable, though the indirect measurement of an observed variable. The variable can be measured and have some measured scores as termed as ***observed variables or indicators*** of the latent variable and represented by rectangles or squares in a SEM model as X_1, X_2…., Y_1, Y_2…. in figure 3-7.

Exogenous versus endogenous latent variables: It is easy in SEM model to distinguish between latent variables that are exogenous and those that are endogenous. Exogenous latent variables as variable ξ_1 in figure 3-7 are synonymous with independent variables; they "cause" fluctuations in the values of other latent variables in the model. Changes in the values of exogenous variables are not explained by the model. Rather, they are considered to be influenced by other factors external to the model. Background variables such as gender, age, and socio-economic status are examples of such external factors. Endogenous latent variables as variables η_1 and η_2 in the model of figure 3-7 are synonymous with dependent variables, and are influenced by the exogenous variables in the model, either directly or indirectly. Fluctuation in the values of endogenous variables is said to be explained by the model because all latent variables that influence them are included in the model specification.

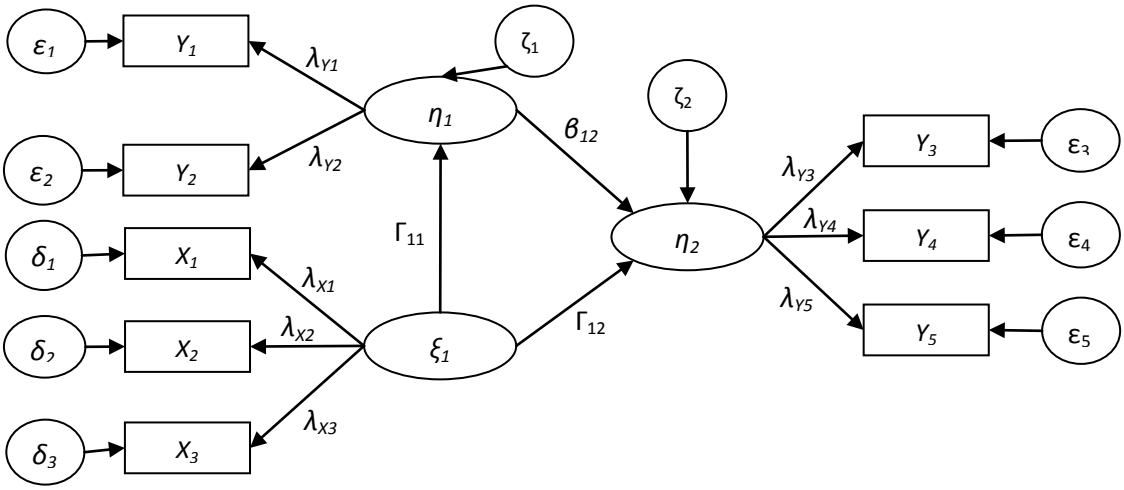


Figure 3-7: A general structural equation model or path diagram

Measurement versus structural model: The general SEM model as shown in Figure 3-7 can be decomposed into two sub-models i.e. a measurement model and a structural model. The measurement model defines relations between the observed and unobserved variables (in figure 3-7 it is represented as ⬭→▭). This relationship is called as path coefficient for regression of an observed variable onto an un-observed

latent variable. In other words, it provides the link between scores on a measuring instrument and the underlying constructs they are designed to measures. The measurement model, then, represents the CFA model. In contrast, the structural model defines relations among the un-observed variables. Accordingly, it specifies the manner by which particular latent variables directly or indirectly influence changes in the value of certain latent variables in the model (in figure 3-7 it is represented as ⬭→⬭). This structural relationship is called as path coefficient for regression of one factor onto another factor. In path diagram, the measurement error associated with an observed variable is represented as →□ and residual error in the prediction of an unobserved factor as →⬭ .

3.5.2. Path diagram and mathematical representation of SEM model estimation

Schematic representations of the models are termed as path diagrams. They provide a visual portrayal of relations, which are assumed to hold among the variables. A path diagram is actually the graphical equivalent of its mathematical representation whereby a set of equations related dependent variable to their explanatory variables. A general path diagram is represented in figure 3-7 which describes its components using different symbols and notations. SEM tools consists of two main parts (i) latent variable model which describes the relationship between the endogenous and the exogenous latent variables and permit the direct assessment of model (ii) measurement model which depicts the correlation between latent and observed variables. Both models described above consist of basic equations that describe the relationship between the independent variables (Bollen, 1989, Byrne, 1998). Structural equation can be represented as:

$$\eta = \beta\eta + \Gamma\xi + \zeta \qquad (3.2)$$

Where

η = *(m x 1),* vectors of the endogenous variables

ξ = *(n x 1),* vectors of the exogenous variables

ζ = *(m x 1),* vectors of the random variables

β = *(m x m),* coefficient matrix for the endogenous latent variable

Γ = *(m x n),* coefficient matrix for the exogenous latent variable and its elements represents direct causal effect of ξ variables on η variables.

It should be noted that β and Γ are the structural coefficients of the model and the equation for the measurement model consists of:

$X = \lambda_X \xi + \delta \rightarrow$ For exogenous variables and $Y = \lambda_Y \eta + \varepsilon \rightarrow$ for endogenous variables

Where

X = *(q x 1),* vectors related to the observed exogenous variables

δ = *(q x 1),* vectors related to errors associated with observed exogenous variables

λ_X = *(q x m)* structural coefficients matrix for the casual effects of the latent exogenous variables on the observed variables

Y = *(p x 1),* vectors related to the observed endogenous variables

ε = (*p x 1),* vectors related to errors associated with observed endogenous variables

λ_Y = *(p x m)* structural coefficients matrix for the latent endogenous variables on the observed variables

3.5.3. Sample size requirements and model estimation

Estimation power of SEM is affected significantly with the sample size and need significant attention. There are several suggestions from researchers for the minimum

sample size; (1) a minimum sample size of 200 is required to reduce the biases to an acceptable level, (2) sample size should be at least 15 times the number of observed variables or at least five times the number of free parameters in the model in case of maximum likelihood estimation, and (3) with strongly kurtotic data, the minimum sample size should be at least ten times the number of free parameters (Golob, 2001, Raykov and Marcoulides, 2000). The fundamental principle of co-variance analysis is used for model estimation. The general strategic framework for testing structural equations, Joreskog (1993) distinguished among three scenarios, which he termed as strictly confirmatory, alternative models and model generating. The primary objective is to locate the source of misfit in the model and to find a model that better describes the sample data. Joreskog (1993) states that although specification may be either theory or data driven, the ultimate objective is to find a model that is substantively meaningful and statistically well fitting. The common model estimation methods include maximum likelihood (ML), generalized least squares (GLS), weighted least square (WLS), asymptotically distribution free (ADF) and un-weighted least squares methods. The most commonly used method is the maximum likelihood. This method maximizes the probability that the observed variances are drawn from a population that has its variance-covariance's generated by the process implied in the model, assuming multivariate normal distribution. The ML is assumed to be stronger with some limitations and yields good statistical estimates of parameters.

3.5.4. Assessment of goodness-of-fit of SEM model

The reliability of a SEM model is checked by indices of goodness-of-fit parameters. Following parameters were used in this study in order check the goodness-of-fit of models i.e. chi-square/ degree of freedom (χ^2/DF), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fir Index (CFI), Root Mean square Residual (RMR) and Root Mean Square Error of Approximation (RMSEA). Different researchers in the field of statistics have recommended permissible values for these parameters of goodness of fit. As the ratio of chi-square to the degree of freedom (χ2/DF) less than 5 indicate a reasonable fit of SEM model (Marsh and Hocevar, 1985), GFI, AGFI, and CFI greater than .90 indicate good fit of model (Bentler and Bonett, 1980, Bentler, 1982), RMSEA less than .08 shows a good fit (MacCallum et al. 1996), RMR less than .08 is acceptable (Hu and Bentler, 1999). By comparing the estimated values with recommended ones, a model can be accepted or rejected, and if rejected, then alternative models can be tested that best fit to the hypothesis and collected data. These recommended values of parameters will be used in next chapters to check fitting of developed models in estimating the respondent's perceptions and attitudes.

3.5.5. Limitations and advantages and of SEM

The arrows directions in a SEM model represent the researcher's hypothesis of causality as shown in figure 3-7. Choices of variables and paths represented by researcher in the model limit the ability of SEM in creating the sample variance and co-variance patterns that have been observed in the nature. Due to this, there may be several models fit equally well to the given data. For SEM, all endogenous variables should be interval or ratio scale variables (in practice, ordinal level endogenous variables are accepted and procedures for interval and ratio level data in AMOS are robust when using ordinal level data with 4 or more categories in large samples). Despite of this, the SEM approach is handy for multivariate analysis.

The SEM model can handle a large number of endogenous and exogenous variables as well as latent variables specified as linear combinations of the observed variables

(Golob, 2003). The SEM methodology has several advantages over older generation of multivariate procedures and has become a popular methodology for non-experimentally research, where methods for testing theories are not well developed and ethical considerations make experimental design unfeasible (Bentler, 1980). Main advantages are listed below:

- It's a confirmatory rather than an exploratory approach to the data analysis
- It has ability to test multiple hypothesis at one time with multiple dependents
- Easiness of use graphical modelling interface
- It provides flexibility in assumptions (allow interpretation of results even in the occurrence of multi-co linearity)
- It can incorporate both unobserved and observed variables
- It enables the estimation of bi-directional relationship between variables whereas regression allows only unidirectional relationship
- It can illustrate direct effects between variables and indirect effects through mediating variables, such as the influence of attitudes on travel behaviour
- It has ability to test coefficients across different groups (multi-group analysis)
- It has ability to handle difficult data and large number of variables
- It provides explicit estimate of error variance parameters
- It is more effective in distinguishing the performance of competing hypotheses
- It assumes ordinal scales and discrete choice variables as individual-specific terms that take advantage of repeated measurements to account for population heterogeneity.
- Allow joint estimation of revealed preference (RP) and stated preference (SP) data

3.5.6. Factor analysis

It is a best-known statistical procedure for investigation of relationships between sets of observed and latent variables. In using this approach to data analysis, the researchers examine the covariance among a set of observed variables in order to gather information on their underlying latent constructs (i.e., factor). In general, the factor analytic model focuses solely on how, and the extent to which, the observed variables are linked to their underlying factors. Specifically, it is concerned with the extent to which observed variables are generated by the under lying latent constructs and thus strength of the regression paths from the factors to the observed variables (the factor loadings) are of primary interest. There are two basic types of factor analysis: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA is designed for the situation where links between the observed and latent variables are unknown or uncertain. The analysis thus proceeds in an exploratory mode to determine how, and to what extent, the observed variables are linked to their underlying factors. Typically, the researchers wish to identify the minimal number of factors that account for co-variation among the observed variables. In contrast, CFA is appropriate to use when the researcher has some knowledge of the underlying latent variable structure (Byrne, 2010). Based on the knowledge of theory and empirical research, researcher postulated relations between the observed measures and the underlying factors and then tests this hypothesized structure statistically.

3.5.7. Application of SEM in transportation research

Various researchers in the field of transportation have applied the SEM methodology for evaluating the travel behaviour, perceptions to service quality of public

transportation modes, road safety, diver's speeding behaviour, and acceptability of TDM measures. In most of the studies, SEM was applied in dealing with latent variables that are traveller's attitudes, norms, beliefs, intention, behaviour, and preferences.

The earliest and well known applications are a joint model developed by Den Boon (1980) of vehicle ownership and usage, and a dynamic model of mode choice behaviour and user's attitudes (Lyon, 1981). Simultaneous equation models of travel behaviour and attitudes by Tardiff (1976) and Dobson *et al.* (1978) that give a full-blown to SEM applications in travel behaviour. Tardiff (1976) used path analysis to show empirical evidence that the causal link from choice behaviour to attitudes is stronger than the link from attitudes to choice behaviour. Various studies using different pattern of simultaneous educational modelling show that attitudes are conditioned by choices, while at the same time, attitudes affects choices (Dobson *et al.* 1978). Using panel survey data for San Diego, California, models developed by Golob *et al.* (1997) which include factors such as changes in travel times, attitudes toward carpooling, mode choice, and use of an exclusive freeway lane for carpools.

Golob and Hensher (1998) employed SEM to address the dichotomy between an individual's behaviour and his or her support for policies that are promoted as benefiting the environment. Golob *et al.* (1997) combined SP and RP data in California to explain vehicle usage as a function of vehicle type, vintage, fuel type to predict use of limited range electric vehicles. Levine *et al.* (1999) present two latent variable models that explain financial support for public transport and support for an institutional reform in public transit planning. Jakobsson *et al.* (2000) used five latent variables to investigate causality among acceptance of road pricing, behavioural intention concerning reductions in car usage, and feelings related to fairness and infringement on personal freedom. Garling *et al.* (2001) explored decision making involving driving choices by using latent variables to test links among attitude towards driving, frequency of choice of driving, and revealed presence of a certain type of decision process. Golob (2001) tested a series of joint models of attitude and behaviour to explain how both mode choice and attitudes regarding a combined HOV and toll facility differ across the population.

Eriksson *et al.* (2006) explain the importance of problem awareness, personal norm, freedom, and fairness in the acceptability of TDM measures using SEM tools. Bamberg *et al.* (2007, 2011) evaluated the importance of soft policy measurers using application of structural equation modelling and joint framework of behavioural theories. Nordfjaern *et al.* (2010) evaluated the driver attitudes, personality variables, and behaviour in different geographical areas. Choocharukul *et al.* (2006) with the application of SEM explain the psychological determinants of people moral obligation of car use reduction and acceptance of car use restriction in Japan and Thailand. Zhengbing *et al.* (2009) explain the influence of learning ability to individual travel behaviour and put the static and dynamic factors as determinants of individual travel decision making. Okamura et al. (2011) apply the SEM tools and identify the importance of auto-oriented and transit oriented lifestyles in presences to use public transportation modes. Other application include: development of structure of user's satisfaction with urban public transport service (Githui *et al.* 2010), causal relationship regarding quality of service of public transport in Indonesian cities (Joewono *et al.* 2010, 2005)' evaluation of urban passenger transport structure (Zhang *et al.* 2005), driver's speeding behaviour using TPB (Warner and Aberg, 2006).

3.6. Summary

This chapter elaborated the various steps of research methodology and characteristics of Lahore city. The described steps included selection of case study city

and appropriate TDM measures for evaluation in case study city, data collection methods, and analysis and modelling techniques. Detailed discussion over analyses and modelling of survey results is given in next four chapters.

Chapter 4

EVALUATION OF ROAD USER'S PERCEPTIONS TO RADIO TRAFFIC INFORMATION

Advance traffic information systems consider as important policy measure and can solve traffic problems in an effective way. In this chapter, existing FM 88.80 traffic radio was selected as advance traffic information TDM measure and its existing and future potential evaluated. This chapter presents the results of influence of radio traffic information on traveller's trip making decisions, and structure of road user's listening propensity, satisfaction with service quality, and future preference with the traffic radio. Initially, it elaborates the significance of radio traffic information from perspective of developing countries as well as Lahore, and then describes the key features of established FM 88.60 traffic radio set up in Lahore. For evaluation of road user's perceptions, a questionnaire survey was conducted in Lahore, and its details are given in appendix A-I and A-II. Results of a questionnaire survey were analyzed for traveller's listening propensity and response behaviour to radio traffic information. Structural equation modelling method was used to develop structure of listening propensity, satisfaction with service quality and future preferences with the traffic radio.

4.1. SIGNIFICANCE OF RADIO TRAFFIC INFORMATION

Now-a-days, advance traveller information system (ATIS) is used to reduce traffic congestion, which provides important traffic information to the traveller at home or office, in vehicle and at station. ATIS includes all those systems that use information technology to inform, monitor, control, and even charge travellers for using the roads, and usually impose as part of ITS initiatives (Bonsall, 2000; Feng and Kuo, 2007). These advance traffic information are very helpful in deciding about mode, route and departure time in trip making (Madanat *et al.* 1995; Emmerink *et al.* 1996; Jou, 2001; Jou *et al.* 2005). The main question has been dealing with the ways in which information provided to the travellers could relieve congestion or not. Early works in developed countries attempt to assess potential system impacts mainly on choice of departure time whereas later studies include also choice of route information (Stern *et al.* 1996). A study in Amsterdam reveals that impacts of radio traffic information and variable message sign information on route choice behaviour are similar (Emmerink *et al.* 1996). Some researchers have shown that content of traffic information (Changchun *et al.* 2010), timely information, accuracy, and relevancy of information and listening frequency (Khattak *et al.* 1995) significantly affect the traveller's route choice, and traveler's departure time significantly influences traveller's route choice response to information.

4.1.1. Developing countries perspective

In developing countries, it is difficult to develop a sophisticated advance traffic information system due to lack of technical, institutional, and financial resources. The education level, accessibility, and affordability of road users are also important factors in deciding the nature of advance traffic information. Traffic information sources can be categorized into audio media (e.g. traffic radio, call centre, etc.) and text media (e.g.

variable message signs, text messages, web-based information etc.). In case of text media, accessibility of travellers to traffic information is one major issue because some people may not have access to internet during travelling or even at home due to unavailability of computer or a mobile phone with internet facility. Other associated issue with text media is readability of travellers of text information because some people cannot read such information due to low education. However, in case of audio media such as traffic radio, it is easy for the road users to get latest information about traffic conditions on roads both in expected and unexpected situations because they can use portable radio, built-in radio in cell phone, and on-board radio in vehicle as well as they can easily understand the information. Such audio sources of getting information are very cheap and affordable even for low-income people, and almost all mobile phones have facility of FM radio. Such simple technologies of providing and getting information can be very useful in developing countries to manage travel demand by influencing individual travel behaviour.

4.1.2. Lahore city perspective

As mentioned in previous chapter, automobile ownership is increasing at alarming rate but the development rate of road infrastructure is very low. This rapid increase in automobile ownership and its usage results heavy traffic congestion on road network. Such traffic problems tend to increase the travel cost and environmental problems by increasing the travel time and fuel consumption. In Lahore, it is difficult to deal with rapid increase in transportation demand just by increasing the supply of transportation infrastructure with limited financial and technical resources. In this context, advance traffic information on traffic situations can be provided to road users in order to make effective travel choices, reduce delays and travel times, lower travel cost and improve the reliability of infrastructure. Currently, traffic conditions in Lahore city are not much stable i.e. on some weekdays very congested during peak hours and on some weekdays normal. Furthermore, sometimes some section of roads is closed due to maintenance, accidents, construction works, and VIPs (very important personality) movements for security reasons. Therefore, up-to-date traffic information for the road users in such unstable and un-expected traffic situations on road network is very important in order to enhance the efficiency of infrastructure. Before launching of traffic radio it was very difficult (not accessible) for road users to get such latest and static information. Now provision of traffic radio has made possible to get up-to-date traffic information. Even un-educated and low-income people can access traffic information because they can use affordable mean to listen traffic radio i.e. mobile phone, portable and on-board radio, and they can understand easily as well.

4.2. SET-UP OF FM 88.60 TRAFFIC RADIO IN LAHORE

Realizing the traffic problems and for their solution, Lahore traffic police launched RASTA (Road and Street Traffic Awareness) Program in Lahore. The main objective of this program is to ensure road safety, improvement in traffic management through effective awareness among the public travelling on roads and streets. Currently, RASTA program includes traffic helpline 1915, website hosting, and FM 88.6 traffic radio. Traffic information is mainly broadcasted through RASTA website (www.rasta.pk) and FM 88.6 radio channel. This FM 88.6 Traffic Radio launched on July 18, 2009 and it is operated by traffic police. It is an infotainment channel and updates the road users about traffic conditions on all major roads after every five minutes. The traffic radio set up mainly consists of '*Control Unit*' and '*Broadcasting Unit*'. Control unit receives the traffic information from '*five control centres'* and directly from traffic wardens deployed at

different locations within the city. The control unit updates the traffic information on the website, whereas broadcasting unit broadcast the updated information. The contents of information include traffic flow conditions on major roads i.e. normal flow, slow traffic, diversion of traffic due to closure of some road section, closure of certain road sections due to accidents, maintenance, and VIPs movements.

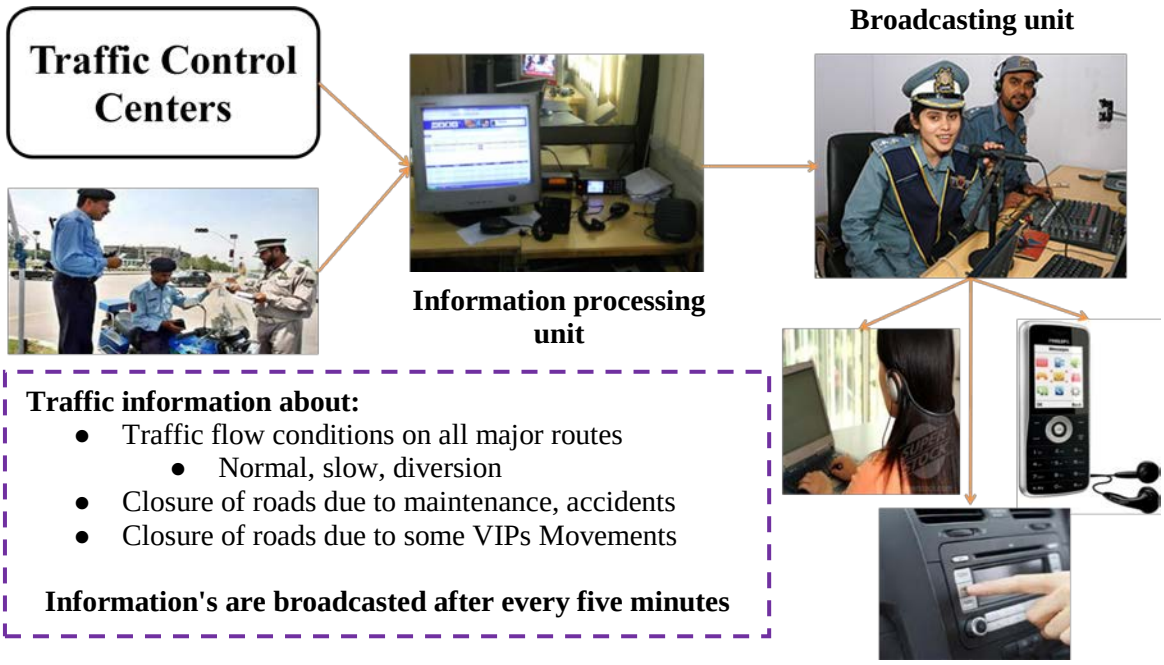
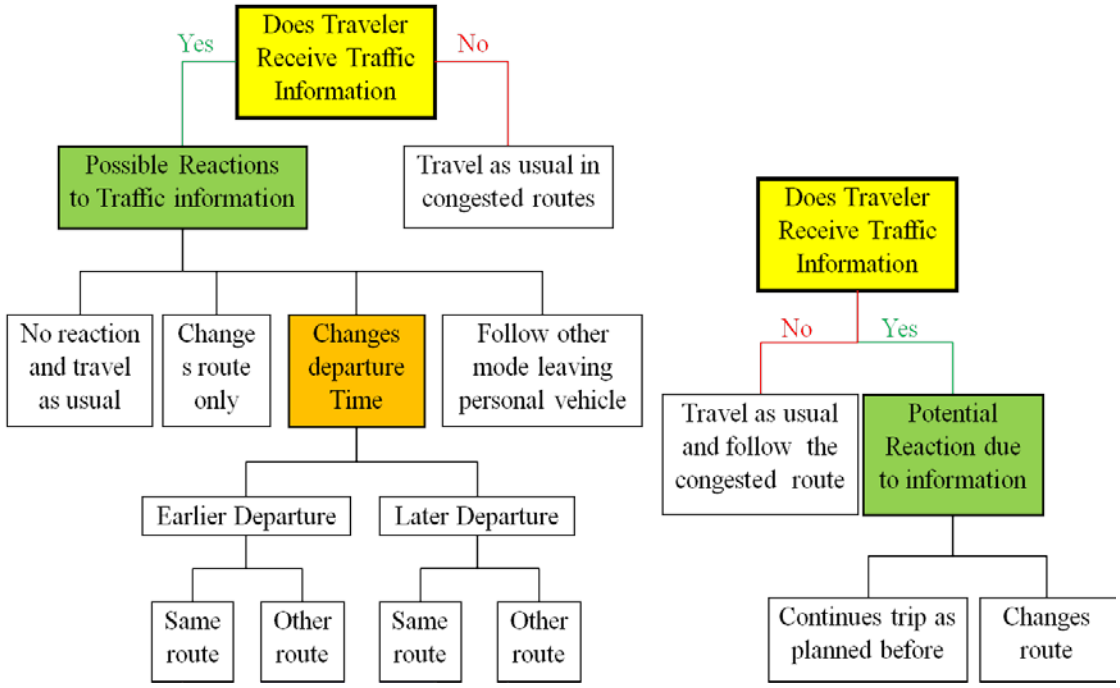


Figure 4-1: Diagram of set-up of traffic radio, and flow of radio traffic information



(a) Effect of pre-trip information on trip attributes (b) Effect of en-route information on route choice

Figure 4-2: Schematic diagram of influence of radio traffic information on trip making

The information of alternative routes is also issued among important origins and destinations. Figure 4-1 elaborates the key components of traffic radio set-up and flow of traffic information. Road users can get latest traffic information by listening FM 88.60 using cell phones, internet, and by tuning on-board radio in vehicle. Based on the perceived information a traveller is expected to change his departure time or route or mode of travelling. A schematic flow of expected reactions to pre-trip and en-route information is presented in figure 4-2. Music, information about traffic rules and safety, news, and awareness programs are also broadcasted in the meanwhile of traffic information.

4.3. DISTRIBUTION OF SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

The details of questionnaire items relating to traffic radio are given in appendix A-I and A-II. Number of samples for commuters and drivers relating to traffic radio were 122 (including samples of email-based survey) and 126 respectively. Questions of arrival time flexibility in morning trip and alternative route availability were not asked from rickshaw and taxi drivers. It was assumed that taxi and rickshaw are on-demand auto transport, and their departure time and route base on passenger's travel pattern. In case of professional drivers, all the respondents are male because female do not drive freight and public transport vehicles, and almost 92% of drivers have education below high school. Table 4-1 shows the distribution of respondent's socio-economic characteristics. According to collected samples, the education level of commuter's is higher from professional drivers. This is, because drivers mainly belong to low income group, whereas commuters middle to high-income group and education level increases with the increase of household income.

Table 4-1: Distribution of socio-economic characteristics of respondents

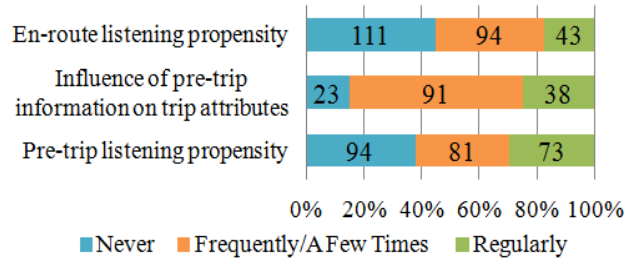
Characteristics of car, motorcycle and public transport users (Total samples: 122)	
Sex	Male (74.6%), Female (25.4%)
Occupation	Students (34.4%), civil employee (26.2%), private employee (21.3%), business (10.7%), Others (7.4%)
Vehicle ownership	No vehicle (27.6%), Car (28.8%), Motorcycle (43.6%)
Education	Below Bachelor (19.7%); Bachelor & above (80.3%)
Usual daily travel mode	Walk/bicycle (10.5%), Car (23.1%), Motorcycle (39.5%), Auto rickshaw (14.2%), Public Transport (6.9%), Others (5.8%),
Trip frequency	5-7 days/week (45.1%), 3-4 days/week (40.2%), 1-2 days/week (13.2%),
Rickshaw (54), taxi (42) and truck drivers (30) (Total samples = 126)	
Education	Below high school (92%), High school and above (8%)
Driving frequency	4-6 days/week (60.3%); Almost every day (33.3%)

4.4. DISTRIBUTION OF LISTENING PROPENSITY OF TRAFFIC RADIO AND RESPONSE BEHAVIOUR TO PERCEIVED INFORMATION

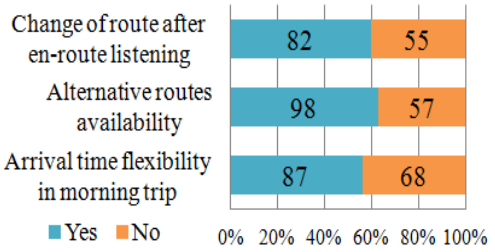
4.4.1. Overall distribution of perceptions to radio traffic information

Almost 42.4% of respondents listen traffic radio using on-board radio in vehicle, 16% use mobile phone and 10% use internet. Almost 32.7% of respondents have frequent, 29.4% regular exposure to radio information and almost 84.4 % trips influenced

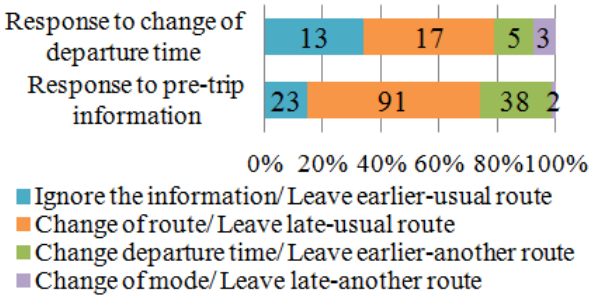
due to pre-trip traffic information as shown in figure 4-3(a). Approximately 59.1% of respondents preferred to change route and 24.7% change departure time after listening traffic radio. According to results, almost 55.2% of respondents have exposure to radio information during travelling as shown in figure 4-3(a) and out of this, almost 60% preferred to change route as presented in figure 4-3(c). This is, because only 63.2 % respondents have alternative route for their usual daily trip as shown in figure 4-3(b). The respondents also asked to report travel time reduction due to change of trip attributes with the provision of radio traffic information. The results show that almost 64 % of respondents have perceived travel time reduction between 6-15 minutes as shown in figure 4-3(d). These results reveal that radio traffic information about traffic flow conditions has significant influence on traveller's trip making decision. Survey results reveal that almost 86.9% of respondents have willingness to use traffic radio in future (start to use: 16.9%, use as present: 18.1% and use more frequently: 51.9%).



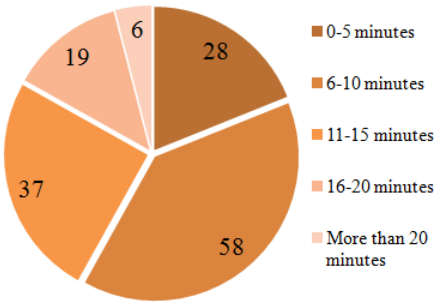
(a) Pre-trip and en-route listening propensity, and influence of pre-trip information on trip attributes



(b) arrival time flexibility, alternative route availability and effect of en-route information on route choice



(c) Response behaviour to pre-trip information



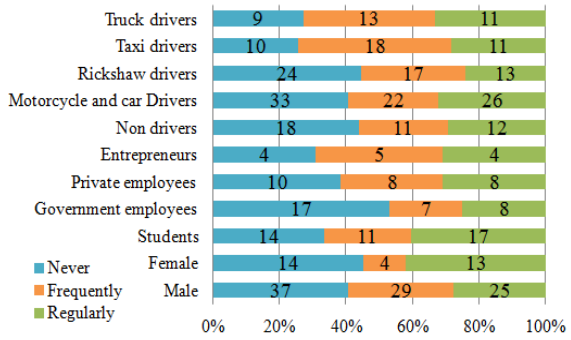
(d) Distribution of reduction in travel time

Figure 4-3: Distribution of listening propensity and response to traffic information

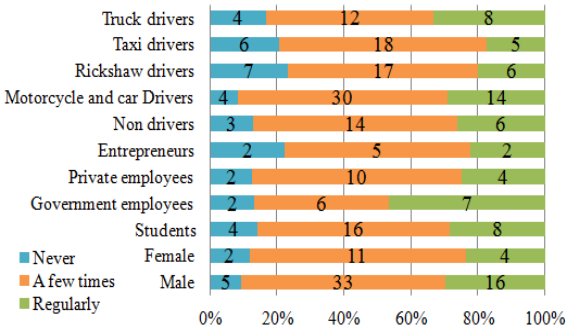
4.4.2. Cross distribution of perceptions to radio traffic information

A cross analysis was conducted of respondent's socio-economic characteristics with listening propensity and response to radio information. This analysis reveal that students, private employees, and entrepreneurs have more listening propensity compared to other groups as shown in figure 4-4(a). Figure 4-4(a) shows that taxi and truck drivers are more frequent listener of traffic radio in professional drivers. This may be due to facility of on-board radio in the vehicle that is difficult in case of rickshaw drivers. Traffic radio is an infotainment channel, which can also be one reason of attraction for different groups. Similarly, figure 4-4(b) shows that trips of male respondents, car and motorcycle drivers are influenced frequently. Figure 4-4(c) shows that most of the respondents preferred to change route over departure time. This is, because only 58 % of the commuters and truck drivers have arrival time flexibility in their morning trip. Radio traffic information also has some influence on trip making of non-drivers (auto-rickshaw users, female travel as passenger on motorcycle). Most of the commuters avoid changing the mode as shown in

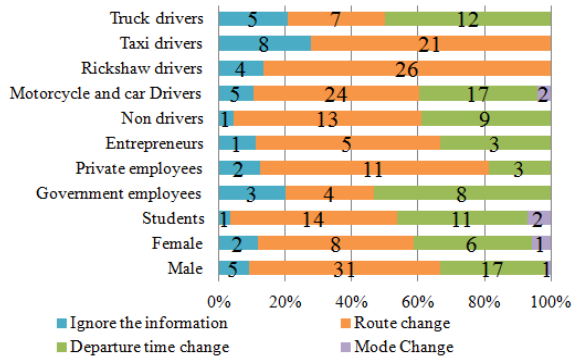
figure 4-4(c). This may be due to inefficiency of public transportation system. In case of en-route listening propensity as shown in figure 4-4(d), private employees, entrepreneur, and professional drivers have more listening tendency.



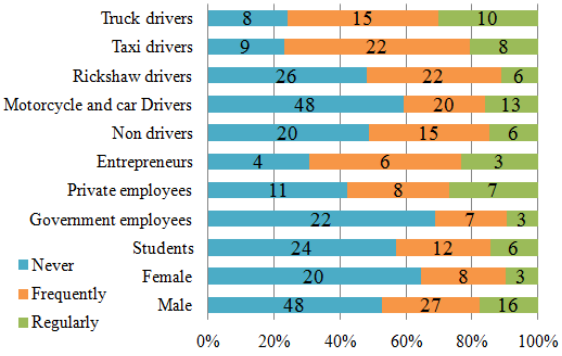
(a) Distribution of pre-trip listening propensity



(b) Distribution of influence on trip attributes



(c) Distribution of response behaviour to pre-trip information



(d) Distribution of en-route listening propensity

Figure 4-4: Cross distribution of listening propensity and influence of information

4.5. STRUCTURE OF SATISFACTION AND FUTURE PREFERENCE WITH TRAFFIC RADIO

The main objective of this section is to evaluate the relationships between current listening propensity, satisfaction with service quality and future preference of road users with traffic radio. It was hypothesized that level of satisfaction with service quality attributes is correlated with current listening propensity, and future preferences with traffic radio are dependent on current listening propensity and satisfaction with the service quality. The observed variables were defined as follows: pre-trip listening propensity (PLP), en-route listening propensity (ELP), influence of pre-trip information on trip attributes (ITA), route conditions (RC) as main purpose of listening (dummy variable), accessibility level (AL), broadcasting frequency (BF), geographical coverage (GC), reliability level (RL), efficiency level (EL), detail of information (DI), and overall performance of traffic radio (OP). All observed variables were considered as ordinal variable from questionnaire results for structural equation modelling except variable of main purpose of listening, which is coded as '1' if purpose of listening is traffic conditions, and '0' otherwise. A confirmatory factor analysis (CFA) was conducted to identify latent variables and their related indicators. Three latent variables were identified and named considering the tendencies associated with various observed variables i.e. listening propensity (LP), performance attributes (PA), and service attributes (SA). The measurement model indicates that all relationships are significant at 1% level of

significance. Variable of detail of information (DI) was excluded from the model because of insignificance. An observed endogenous variable of future use of traffic radio (UTRF) was introduced in developing structural model. This variable was coded as '1' for more frequently use, and '0' otherwise. The structure model shows that future preference of road users with traffic radio are positively influenced by current listening propensity and satisfaction with performance and service attributes. The indices of goodness of fit parameters are lying within permissible limits i.e. χ^2/DF < 5.0, GFI and CFI > 0.90, AGFI ≈ 0.90, RMR < 0.05 and RMSEA < 0.08, which show that this model has good estimation of respondents' perceptions to traffic radio. This model implicates that use of traffic radio in future is highly dependent on current listening propensity and satisfaction with service quality of traffic radio. Therefore, it can be argued that improvement in service quality would enhance the use of traffic radio in future and can attract potential listeners. In addition, improved service would be useful in reducing the traffic congestion and other road network problems by influencing the travelling and driving behaviour of road users.

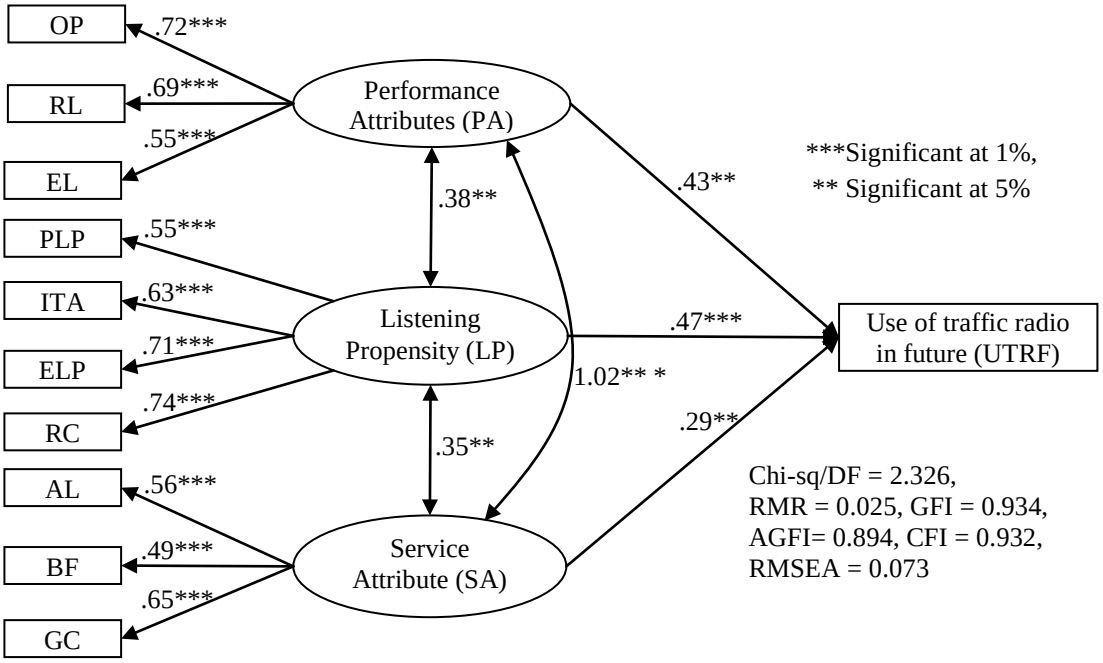


Figure 4-5: Structure of listening propensity, satisfaction, and future preference with traffic radio

4.5.1. Estimation of model parameters for commuters and drivers

The model parameters were estimated separately for commuters and drivers using the base model as presented in figure 4-5. The standardized estimates and indices of goodness of fit of both models are presented in table 4-2. The results of commuters' model show that all the relationships and co-relationships are positive and significant at a significance level of 1 %, except co-relationship between listening propensity (LP) and service attributes (SA), which is significant at 5 %. Similarly, all the relationships and co-relationships of drivers' model are significant at 1 or 5 % of level of significance except relationship between performance attributes (PA) and use of traffic radio in future (UTRF). This is, because drivers have low willingness compared to commuters to use traffic radio in future in case of service improvements. By comparing the standardized estimates and their significance, and goodness of fit indices of both models with base

model, it can argue that commuter's model has good representation of overall perceptions to radio traffic information.

Table 4-2: Standardized estimates of drivers and commuters model

Relationships	Commuters	Drivers
Measurement Equation		
OP ⟵ PA	0.72***	0.61***
RL ⟵ PA	0.67***	0.71***
EL ⟵ PA	0.57***	0.55***
PLP ⟵ LP	0.82***	0.93***
ITA ⟵ LP	0.80***	0.45***
ELP ⟵ LP	0.43***	0.89***
RC ⟵ LP	0.68***	0.80***
AL ⟵ SA	0.53***	0.46***
BF ⟵ SA	0.43***	0.34**
GC ⟵ SA	0.67***	0.35***
Co-relations between latent variables		
PA ⟷ LP	0.37***	0.46***
PA ⟷ SA	1.03***	1.04***
SA ⟷ LP	0.20**	0.35**
Structural Equation		
UTRF ⟵ PA	0.52***	0.08
UTRF ⟵ LP	0.29***	0.62***
UTRF ⟵ SA	0.42***	0.23***
Parameters of goodness of fit		
Chi-sq/ DF	1.736	1.712
GFI	0.912	0.910
AGFI	0.858	0.855
CFI	0.882	0.932
RMR	0.078	0.050
RMSEA	0.078	0.075

Note: ***Significant at 1 %, **Significant at 5%

4.6. SUMMARY OF FINDINGS

The results showed that most of the road users prefer to change route instead of departure time or mode. It means that traffic information source has significant influence on route choice behaviour of road users. Almost 38 % of respondents did not show any exposure to radio information. It is suggested that there is need to make public aware about traffic radio either through workshops or advertisements in the newspaper. The findings of structural model explain that future preferences of travellers with traffic radio are significantly affected by satisfaction with service quality and current listening exposure and propensity. From results of structural model, it is said that broadcasting frequency, accessibility, geographical coverage, and reliability of information are key features in defining the usefulness of traffic radio. It is argued that such simple advance traffic information sources are very useful in order to make individual trip planning more effectives, and address congestion-oriented problems.

Chapter 5

EVALUATION OF COMMUTER'S SATISFACTION WITH PUBLIC TRANSPORTATION, AND ATTITUDES TOWARDS TDM MEASURES CONSIDERING LIFESTYLES AND ATTITUDES

This chapter presents the results of evaluation of commuter's satisfaction with existing public transportation modes, and attitudes towards TDM measures considering lifestyles, social and travel related attitudes. Two modes of existing public transportation were selected for evaluation of commuter's satisfaction, and their future potential in the framework of public transport improvements as a TDM measure. Second part of this chapter discusses the general lifestyles and attitudes of people, and their influence on attitudes towards individually presented TDM measures. The analyses in this chapter are based on questionnaire survey results of 631 samples that were obtained in phase-I survey. The details of questionnaire items related to analyses of this chapter are given in appendix B. These analyses include the distribution of respondent's socio-economic characteristics, commuter's satisfaction with public transportation, perceptions to lifestyles and attitudes, commuter's preferences to use public transportation and attitudes towards TDM measures under the influence of lifestyles and attitudes.

5.1. DISTRIBUTION OF RESPONDENTS SOCIO-ECONOMIC CHARACTERISTICS

5.1.1. Overall distribution

The female respondents account only 23.3% of sample, which is quite less compared to the total share of population. This is, because female do not drive motorcycle and bicycle, and do not work in commercial sectors (business, shops, etc.). Sample shows that 64.6% of respondents have education bachelor or above, which is much higher than the actual literacy rate in Lahore. This is due to majority of car and potential car users in the sample, because they belong to medium to high-income category, and thus education level increases with the increase of income in this study. Sample represents a good mix of different mode users as well as occupations. The survey results show that almost 83.5% respondents have trip frequency 5-7 days a week and 10.6% 3-4 days a week. This depicts that collected samples nearly represent daily travellers in Lahore. Almost 33.3% of respondents have car and 35.5% motorcycle driving license respectively. The respondents were also asked whether they drive car and motorcycle or not. Sample results show that 39.8% respondents drive car and 52.5% drive motorcycle. It means some people drive car and motorcycle even without driving license. The respondents who drive vehicle asked for how did they learn driving. Results show that 35.9% are self-trained, 52.7% learned driving from friends or family members and only 11.4% learned from a driving school. Almost 76.3% of respondents were aged between 21-40 years and this distribution is very much similar to distribution of age structure in Lahore as presented in figure 3-3(b). Average monthly household and personal income of respondents lies in 21,000-30,000

PKR and 10,000-15,000 PKR respectively. Motorcycle has highest share in modal share of this questionnaire survey. Auto-rickshaw is more frequently used by middle and high-income people than taxi; therefore, its share may be negligible or very little. Office and campus transport include both university students transport and transport for employees from organizations. The detail of socio-economic characteristics is given in table 5-1.

Table 5-1: Distribution of respondent's socio-economic characteristics

Characteristic	Distribution (%)
Gender	Male (76.7), Female (23.3)
Marital Status	Single (60.7), Married (39.3)
Age (years)	< 20 (14.4), 21-30 (56.3), 31-40 (20), 41-50 (6.97), above 50 (2.36)
Education	Below high school (8.9), high school (8.9), higher secondary school (11.9), diploma (5.7), bachelor (36.6), master and above (28.1)
Occupation	Students (23.6), Government employees (20.8), Private employees (29), Business (15.7), Others (lawyers, labour, housewife) (11)
Personal income per month (PKR)	< 10,000 (37.3), 10,000-20,000 (23.1), 21,000-30,000 (16), 31,000-40,000 (10.9), 41,000-70,000 (7.3), > 70,000 (5.4)
Household income per month (PKR)	< 10,000 (5.2), 10,000-20,000 (14.9), 21,000-30,000 (34.2), 31,000-40,000 (22.8), 41,000-70,000 (10.1), >70,000 (12.7)
Car ownership	None (52.9), 1 unit (29.5), 2 unit (13.3), 3 or more unit (3.4)
Motorcycle	None (31.1), 1 unit (46.3), 2 unit (17.6), 3 or more unit (5.1)
Driving license	Car (33.0), motorcycle (35.1)
Drive vehicle	Drive car (39.8), drive motorcycle (52.5)
Driving learning	Self trained (35.9), from friends/ family members (52.7), driving school (11.4)
Most frequent travel mode (modal share)	Car (25.51), motorcycle (35.5), rickshaws & taxi (7.13), public bus (7.6); wagon/minibus (4.6), office/campus transport (5.86), walk/bicycle (9.2)

5.1.2. Cross-distribution of socio-economic characteristics

A cross-analysis was conducted between modal share and vehicle ownership. Initially, sample was segmented for vehicle ownership i.e. no vehicle, only motorcycle, car and motorcycle, and only car. The results of cross analysis as shown in table 5-2 depict that car and motorcycle owners prefer to use their private vehicle instead of other modes. From this analysis, sample was segmented into four categories based on mode dependency and captivity of choice. These segments include car oriented including auto-rickshaw and taxi users (204), motorcycle oriented (224), public transport oriented including office/school transport (145) and non-motorized modes (NMM) group (58).

Results as presented in table 5-3 indicate that, male are dominant in motorcycle oriented group and female in car and public transport oriented group. This is, because female do not drive motorcycle and just travel as passenger and in case of car they can drive, and travel as a passenger. It means the travel behaviour of female is dependent on male in motorcycle-oriented group. Car usage increases with the increase of age, and motorcycle is dominant mode for age group of 21-30 years. Public transport use decreases with increase of age. It reveals that as people approached to higher age their income increases, which results increase of car and motorcycle ownership and usage. The dominance of motorcycle in age group 21-30 years indicates that graduate students and fresh graduates and workers initially rely on motorcycle, and later on approach towards car ownership and usage with the increase of income. Car usage is higher in small and motorcycle in big households. This is very realistic because household size decreases with the increase of income and car ownership also increase with the increase of income. Car usage again increases with the increase of education, whereas public transport use decreases with increase of education. This is, because education level in Lahore increases with the increase of income and this support the findings of increase in car use with

increase of education. Motorcycle group is dominant in middle-income category. There is no significant variation among four groups for work or study trip. However, car and motorcycle oriented people travel more for shopping and recreational trips compared to other groups because other groups belong to low income category. This depict that these groups are captive in mode choice and have low tendency for shopping and recreational trips. This may be due to expensive and inefficient public transport in the city.

Table 5-2: Distribution of modal share versus vehicle ownership (%)

	Frequent travel mode							
Vehicle ownership	Car	Auto-rickshaw / taxi	Motor cycle	Office/ school transport	Public bus	Public Wagon	Qingqi	Walk/ Bicycle
No vehicle	0.0	6.59	2.20	7.69	29.67	14.29	13.19	26.37
Only motorcycle	0.82	8.20	57.79	5.33	8.20	4.92	5.33	9.43
Car and motorcycle	42.49	4.15	39.90	7.77	1.04	0.00	0.52	4.15
Only car	72.82	10.68	3.88	2.91	0.97	2.91	2.91	2.91

Table 5-3: Distribution of socio-economic characteristics across four mode users segments

Socio-demographics	Car oriented (%)	Motorcycle oriented (%)	Public transport oriented (%)	Non-motorized oriented (%)
Gender				
Male	27.7	40.7	21.9	9.7
Female	47.6	18.4	26.5	7.5
Age				
≤ 20years	33.0	22.0	36.3	8.8
21-30	27.6	43.4	20.0	9.0
31-40	42.9	27.0	26.2	4.0
> 40 years	37.3	27.1	13.6	22.0
Household members				
≤ 5	39.3	29.4	24.3	7.0
> 5	25.5	41.5	21.7	11.3
Education				
Below bachelor	18.4	38.1	33.2	10.3
Bachelor & above	40.0	24.1	17.4	8.6
Personal Income				
Low income	24.3	27.7	34.0	14.0
Middle income	21.9	48.6	22.7	6.9
High income	62.4	26.2	6.0	5.4
Household income				
Low income	12.6	29.9	37.8	19.7
Middle income	18.1	44.9	27.8	9.3
High income	51.7	30.9	12.8	4.5
Work/study trip				
5-7 days a week	32.1	35.6	21.8	10.3
3-4 days a week	31.1	41.9	24.3	2.7
1-2 days a week	31.4	37.1	22.9	8.6
A few times a month	37.5	34.4	18.4	9.4
Shopping trip				
Weekly	49.7	27.5	15.6	7.2
A few times a month	26.1	38.4	25.6	9.9
Recreational trip				
Weekly	43.4	32.4	17.6	6.6
A few times a month	29.3	36.4	24.4	9.9

5.2. COMMUTER'S SATISFACTION WITH EXISTING PUBLIC TRANSPORTATION

This part discusses the results of public satisfaction with existing public transport modes. Initially, conventional and factor analyses were conducted for commuter's perceptions to service of Daewoo bus and Wagon service. The extracted factors were used to develop structural model of satisfaction.

5.2.1. Overall satisfaction with Para-transit (Wagon) and Daewoo bus service

Figure 5-1 shows that commuter's satisfaction level is quite low with most of the attributes of wagon service quality. Almost 50% of respondents are satisfied with fare level and more than 40 % with service frequency, walking time to wagon stop and ticket and fare collection system. These results imply that the quality of wagon service is very poor and major improvements are required in this regard. The results of perceptions to service quality of Daewoo bus as presented in figure 5-2 show that more than 60% of respondents are satisfied with punctuality, travel time reliability, and convenience level of bus service. Approximately 70% of respondents are satisfied with physical condition of bus, comfort level, safety, and security of bus service. Almost 65% of respondents are satisfied with attitude of drivers and conductors. Physical condition of bus stop, walking time to bus stop, ticket and fare collection system, travel cost, and frequency attributes secured less satisfaction from the commuters. These results imply that Daewoo Bus Company needs to increase service frequency, and reduce fare level in order to enhance public satisfaction. The geographical coverage both in terms of routes coverage, and bus stop need to address as well. The introduction of electronic fare collection system can also enhance the performance of bus service. In both modes, commuter's satisfaction is higher with Daewoo bus service compared to wagon service. It means Daewoo bus service has more potential to keep existing users, and attract potential public transport users by making some improvements.

5.2.2. Factor analysis

Factor analyses were conducted by using results of respondent's perceptions to service quality of wagon and Daewoo bus. Three factors were extracted and named considering the nature and tendencies associated with observed variables from users perceptive i.e. symbolic, functional, and cost and time as presented in table 5-4. It was assumed that time related attributes have monetary nature or value from user perspective. Similarly, increase or decrease in service frequency tends to affect out-of-vehicle travel time of users, and operational cost of service. Consequently, change in frequency and operational cost would have effect on travel cost and time. Therefore, these variables were combined in one factor i.e. cost and time.

5.2.3. Structural equation modelling of public satisfaction with wagon and Daewoo bus service

The extracted factors were used to construct the structural models of commuter's satisfaction with Daewoo bus and wagon service. A typical structural framework is shown in figure 5-3, and results of SEM in table 5-5. The results of wagon model show that overall commuter's satisfaction has positive relationship with the change of satisfaction to symbolic and functional factors. It means that commuter's satisfaction can be enhanced by providing a safe, secure, comfortable, convenient, and punctual service.

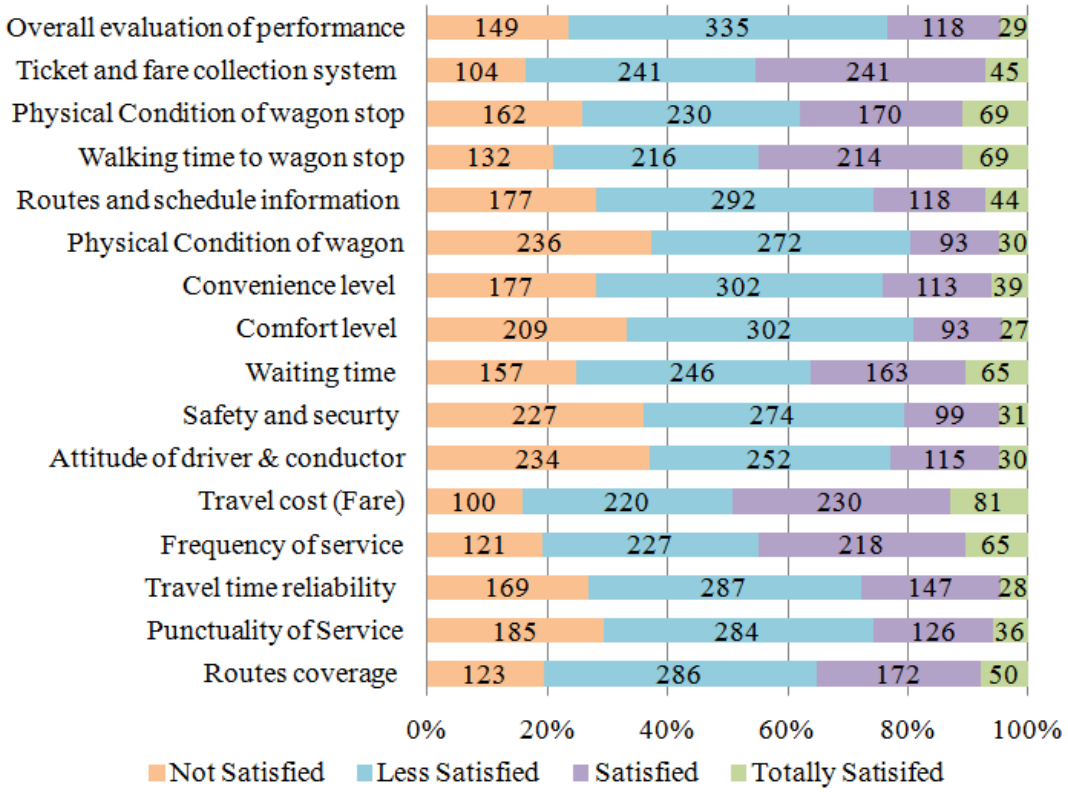


Figure 5-1: Distribution of respondent's overall satisfaction with wagon service

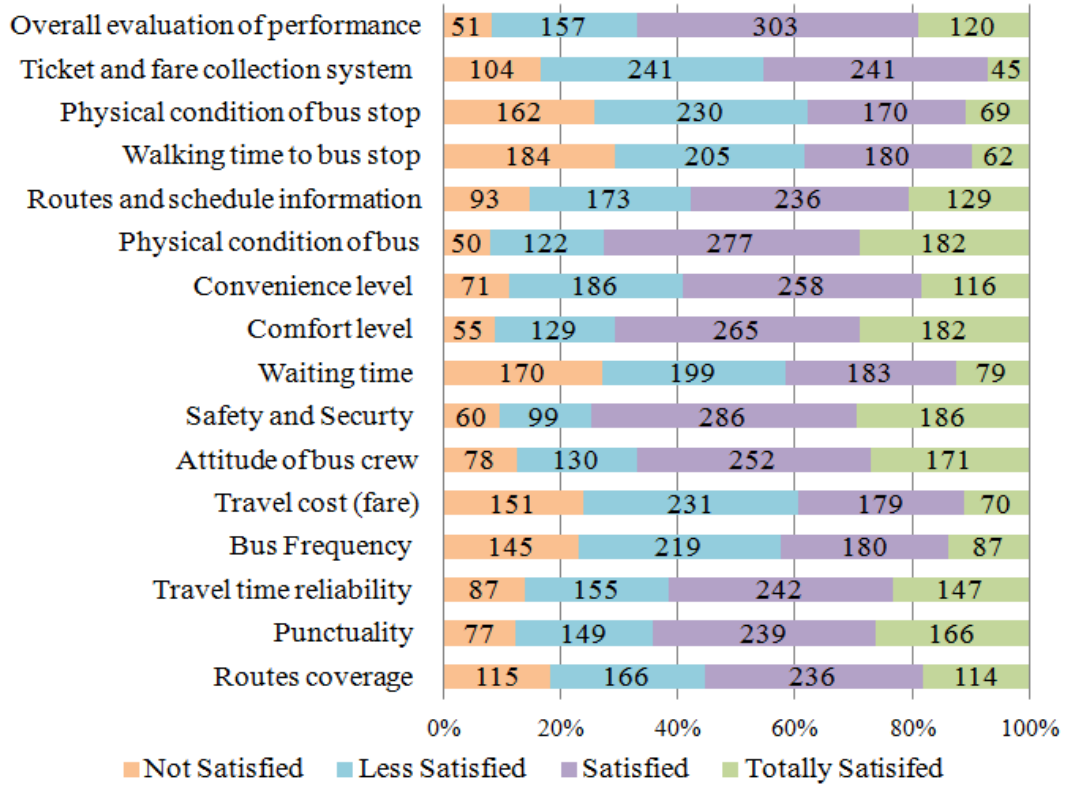


Figure 5-2: Distribution of respondent's overall satisfaction with Daewoo bus service

However, the satisfaction level decreases with the increase in travel cost and time factors. It means that satisfaction would reduce with increase in fare level, waiting and ingress/egress time. Therefore, to enhance satisfaction with wagon service the fare level need to reduce and influence of time factors need to minimize i.e. increase service frequency and reduce walking time to/ from stop of wagon service. In addition, improvements in fare collection system and physical conditions of bus stop would help in enhancing the satisfaction.

Table 5-4: Rotated factor loadings for Para-transit and Daewoo bus service

Latent variables or factors	Wagon		Daewoo bus	
	Observed variables	Factor loadings	Observed variables	Factor loadings
Symbolic	Comfort level	0.726	Comfort level	0.733
	Physical condition of vehicle	0.696	Safety and security	0.731
	Crew attitude	0.655	Bus physical condition	0.711
	Safety and security	0.608	Crew attitude	0.599
	Routes and schedule information	0.480	Convenience level	0.506
Functional	Punctuality of service	0.664	Punctuality	0.719
	Routes coverage	0.656	Travel time reliability	0.633
	Frequency of service	0.613	Routes coverage	0.464
	Convenience level	0.494	----	---
Cost and time	Walking time to stop	0.663	Waiting time	0.648
	Waiting time at wagon stop	0.519	Bus service frequency	0.632
	Travel time reliability	0.464	Walking time to bus stop	0.593
	Travel cost	0.463	Travel cost	0.429

Note: variables with a factor of 0.4 or more are reported only. All the factor loadings or co-relations were significant at 1%.

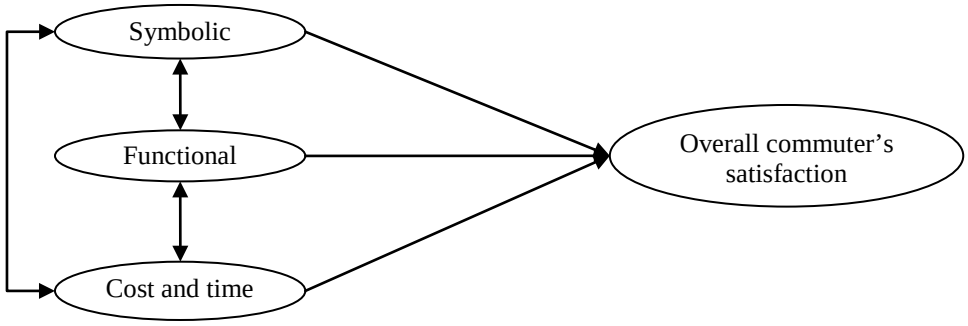


Figure 5-3: A typical structure of commuter's satisfaction with public transportation

The results of structural model of Daewoo bus service indicate that overall satisfaction is positively affected with change of people's satisfaction with symbolic, functional, and cost and time factors. The sign of structural relationships of symbolic and functional dimensions with overall satisfaction are same as for wagon service, however, cost and time factor has opposite to wagon service. It means that commuters perceive service quality of different modes differently, and influence of corresponding satisfaction factors is different on overall satisfaction for different modes. In the model of Daewoo bus, the inclusion of frequency attribute with cost and time factors result a positive impact on satisfaction. This is, because increase in service frequency will decrease the out-of-vehicle travel time i.e. waiting time, but it may increase travel cost (fare). From this, it is argued that a trade-off is required in setting the service frequency and fare level in order

to enhance the public satisfaction. In addition, it can be said that people may accept higher fare if the impacts of time factors are reduced. More reliable and punctual service can increase the public confidence to use bus service in future. Similarly, improvements in image or symbolic attributes would result significant change in public satisfaction. There is need to increase service accessibility both by increasing routes and decreasing the egress/ingress time. Model results also depict that satisfaction is positively affected with the physical conditions of bus stop and ticket and fare collection system. Therefore, by improving the bus stop conditions and employing electronic fare collection system would result a more satisfactory service. The indices of goodness of fit for both models are falling within permissible range, i.e. Chi-sq/DF < 5.0, RMR < 0.05, GFI, CFI > 0.90, AGFI ≈ 0.90 and RMSEA < 0.08 which indicate that these models have good fit in estimating the respondent's perceptions.

Table 5-5: Standardized estimates of measurement and structural equations

	Overall commuter's satisfaction	
Measurement equations	Wagon	Daewoo bus
Overall evaluation of performance	0.713***	0.734***
Ticket and fare collection system	0.531***	0.263***
Physical condition of bus stop	0.325***	0.446***
Co-relations between latent variables		
Symbolic ◄- - -► functional	0.78***	0.80***
Functional ◄- - -► cost and time	1.03***	0.69***
Symbolic ◄- - -► cost and time	0.74***	0.62***
Structural equations		
Symbolic	0.33***	0.37**
Functional	0.87**	0.39**
Cost and time	-0.58*	0.35***
Parameters of Goodness of fit		
Chi-sq/DF	4.262	1.884
RMR	0.042	0.053
GFI	0.928	0.908
AGFI	0.895	0.869
CFI	0.914	0.945
RMSEA	0.072	0.066

Note: ***significant at 1%, **significant at 5% and *Significant at 10%.

5.3. ANALYSIS OF PERCEPTIONS TO LIFESTYLES, ATTITUDES, AND INTENTIONS

5.3.1. Overall average response and average response of four mode users identified segments

Overall average response and average response of four modes users segments were calculated for lifestyles, attitudes, preferences in trip making, and behavioural intentions. These results are presented in table 5-6. Higher average value shows the more positive evaluation of corresponding statement. Comparison among four groups indicates that car-oriented group has more priority to comfort and time saving over cost saving compared to other groups. It implies that comfort and time saving are main reasons to use car. Non-motorized mode users have more concern about safety in trip making. Respondents belonging to public transport and NMM groups have more priority to reliability of service compared to car and motorcycle oriented. Most of the respondents in all groups almost

have same opinion about preferences of time saving to cost saving. *These facts imply that a comfortable, time saving and reliable public transport service is the demand than a cheaper service to accommodate users of all types*.

Transit and non-motorized modes users have low potential to own a car and more priority to cheaper fare due to low income. Whereas car and motorcycle oriented people have more priority to shorter travel time over cheaper fare. These groups also have more preference for safe and secure surrounding in both living and working than other groups. All the groups nearly have same propensity to change lifestyle with the change of income. This fact argues that with the increase in income level current public transport and motorcycle users might become car users in future, if proper attention is not given to improve public transportation facilities. Transit and NMM users have less favour to social factor of '*travelling mode reflects their personality in the society'* than car and motorcycle users. It means status symbol or social respect is one reason of high trend of automobile ownership and usage. Car and motorcycle users have shown the more positive evaluation of attitude '*avoid interacting with unknown people'*. It means privacy or independency from others is also one factor in using private transport. Almost all groups have high and same intentions of ride sharing with family members or friends for commuting. Public transport and NMM groups give more priority to walk or use bicycle for a trip length of 1-2 km compared to car and motorcycle users, which depicts that these groups prefer to use private vehicle even for shorter trip. Public transports users showed more intention to use public transport even if they have or would have a car, because they do not expect to have a car in future due to low income. Public transport and NMM groups prefer to change mode over route, whereas other groups prefer route to mode. This is, because for auto users it is easy to change route compared to mode in case of traffic congestion. Both car and motorcycle users highly agree that using car or motorcycle increase their work efficiency. Most of the auto users are willing to use public transportation in case of heavy parking restrictions and motorcycle users have more potential for this. Car users gave high priority to attitudes of 'air-conditioned public transport and it is difficult to use public transport in rain or during hot weather'. Car users have more tendencies to use other modes of transport if they offer shorter travel time compared to motorcycle users. Public transport and NMM groups showed more willingness 'to do not use or reduce usage' of private vehicle in future for reduction of traffic congestion and environmental impacts. These results also reveal that people's intentions 'to do not use or reduce usage' of private vehicle are higher for environmental reasons compared to traffic congestion. It means that people have more concern about air pollution in the city than traffic congestion.

Table 5-6: Average response of different groups to lifestyles, attitudes, and behavioural intentions

Lifestyles, attitudes and behavioural intentions		**Car**	**MC**	**PT**	**NMM**	**OA**
1	I prefer time saving to safety in trip decision	2.36	2.47	2.36	2.72	2.43
2	I prefer time saving to cost saving in trip decision	2.97	2.94	2.97	2.93	2.96
3	I prefer reliability (schedule and travel time) to cost saving in trip decision	2.92	2.90	2.99	3.18	3.01
4	I prefer reliability (schedule and travel time) to comfort in trip decision	2.83	2.79	2.86	3.13	2.85
5	I prefer reliability (schedule and travel time) to time saving in trip decision	3.02	2.83	2.93	2.97	2.93
6	I prefer comfort to cost saving in trip decision	3.08	2.87	2.73	2.97	2.91
7	I prefer comfort to time saving in trip decision	2.87	2.79	2.71	2.69	2.81

8	I select a mode that can protect me from traffic accident for the first reason	3.32	3.45	3.23	3.57	3.37
9	It is better for me to have a car	3.40	3.44	3.22	3.24	3.35
10	I like to live in secure and safe surrounding	3.73	3.75	3.51	3.60	3.62
11	I like to work in secure and safe surrounding	3.75	3.73	3.64	3.62	3.67
12	I like to live in Joint Family System	2.84	3.11	2.97	3.28	3.00
13	I prefer to live near to my work/study place	3.25	3.37	3.23	3.45	3.31
14	I avoid to interact with unknown people	2.87	2.83	2.61	2.68	2.74
15	Shorter travel time is the first priority	3.35	3.33	3.19	3.11	3.24
16	Cheaper fare is the first priority	2.86	3.03	3.13	3.23	3.02
17	I am very keen to change my lifestyle with change of income	3.14	3.20	3.19	3.15	3.17
18	It disturbs me if I am forced to change in my routine	3.08	3.03	3.07	3.25	3.07
19	I do not want to disturb my schedule due to traffic congestion	3.16	3.30	3.17	3.35	3.23
20	Travelling mode affects my personality image	3.02	2.99	2.92	2.78	2.96
21	I do not want to take longer trips for shopping	2.96	2.95	3.06	3.08	2.99
22	I like ride sharing with my friends or colleagues going to work or study	2.90	3.07	3.07	3.22	3.03
23	I prefer ride sharing with my family members going to work or study	3.11	3.04	3.15	3.05	3.09
24	I prefer to walk or use bicycle for a trip length of 1-2 km	2.70	2.86	3.15	3.15	2.90
25	For long trips, I like to use car or taxi/auto-rickshaw	3.24	3.23	2.89	3.00	3.07
26	Even if I have or will own a car, I do/would use public transport sometimes	2.60	2.47	2.78	2.57	2.59
27	When traffic is congested, I avoid to use personal vehicle or auto-rickshaw/taxi	2.55	2.58	2.76	2.77	2.63
28	I prefer to change means of transportation due to traffic congestion	2.65	2.76	3.04	3.02	2.81
29	I prefer to change travel route in case of traffic congestion	3.43	3.31	3.22	3.18	3.28
30	Using car or motorcycle increases my work efficiency	3.36	3.45	--	--	3.36
31	It is acceptable for me to use public transport for short trips like 3-5 km	2.48	2.55	--	--	2.57
32	It is acceptable for me to use public transport if parking facility is not available at destination or work place	2.64	2.71	--	--	2.72
33	It is preferable for me to use public transport, if parking charges are very high	2.53	2.62	--	--	2.59
34	I prefer to use air-conditioned bus whenever I need to use public transport	3.18	3.06	--	--	3.07
35	It is not possible for me to use public transport during rain or hot weather	2.98	2.84	--	--	2.86
36	I would prefer to use personal vehicle even if other modes offer shorter travel time	2.54	2.89	--	--	2.66
37	It is not possible for me to use public transport when I have trip other than work/study trip	2.88	2.93	--	--	2.90
38	In any case, I try to avoid to use public transport	2.55	2.67	--	--	2.58
39	I personally feel responsible to do not use/ reduce usage of private vehicle in future in order to reduce traffic congestion	2.46	2.43	2.53	2.48	2.47
40	I personally feel responsible to do not use/reduce usage of private vehicle in order to decrease negative effects on the environment	2.73	2.76	2.83	2.77	2.77

Note: MC: motorcycle, PT: public transport, NMM: non-motorized modes, OA: overall

5.3.2. Influence of lifestyles and attitude on commuter's preference to use public transportation

It is assumed that people's preference to use public transportation is affected with their lifestyles and attitudes. Lifestyles and attitudes were included as observed variables in the measurement model and represented by using question number as given in table 5-6. Two latent variables were defined considering the tendencies associated with various lifestyles and attitudes i.e. *auto oriented* and *transit oriented* factors. The measurement model shows that the standardized regression weights of all observed variables are positive and significant at 1% level of significance. This measurement model used to construct the structure of commuter's preference to use public transportation 'even if they have a car or will own a car'. The results as presented in figure 5-4 show that transit oriented factors have positive influence on preference, whereas auto oriented factors negative influence on preference to use public transport. This model infers that auto-oriented factors tend to reduce, whereas transit-oriented factors tend to enhance the use of public transportation. The indices of goodness of fit parameters are lying within the permissible limits i.e. chi-sq/DF < 5.0; RMR < 0.05; GFI, AGFI & CFI > 0.90 and RMSEA < 0.08, which indicates that model has reasonably good fit in predicting commuter's preferences.

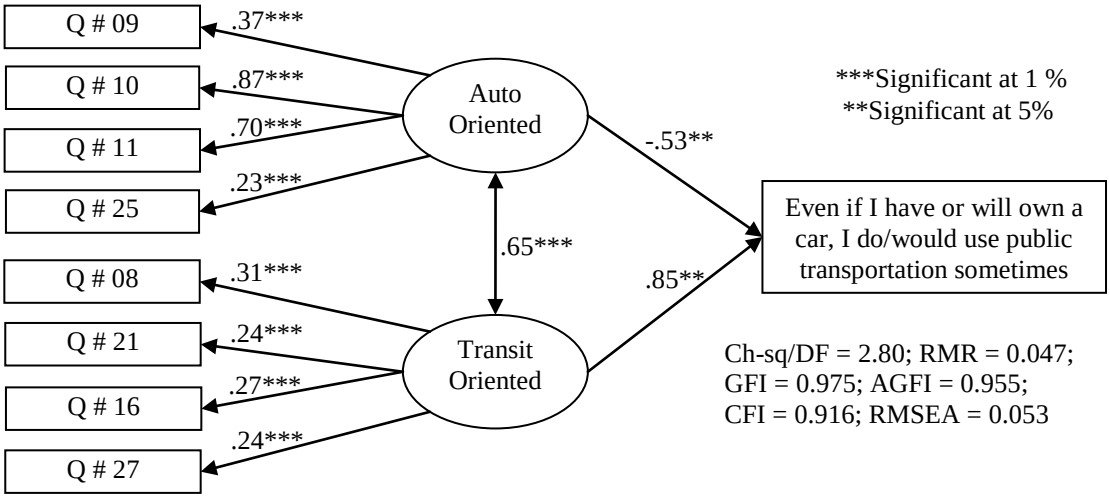


Figure 5-4: Structure of lifestyles, attitudes, and preference with public transportation

5.3.3. Factor analysis

A factor analysis was conducted using results of respondent's perceptions to lifestyles and attitudes and three factors extracted. These factors or latent variables were named considering the tendencies associated with observed variables of each factor and seeking the concept of theory of planned behaviour i.e. personality traits, travel attitudes (travel attitudes under community, situational and transportation system factors), and perceived behavioural control (individual's perceived ability to perform certain behaviour e.g. change of schedule due to other people, interaction with unknown people and control over shorter travel time in travelling). Similarly, factor loadings were estimated for two indicators of latent variable of intentions. These results are presented in table 5-7.

Table 5-7: Rotated factor loading for lifestyles, attitudes, and intentions

Travel attitudes (TA)	Factor loadings	α
I prefer to change travel route in case of traffic congestion	0.623	0.64
I prefer to walk or use bicycle for a trip length of 1-2 km	0.531	
I like ride sharing with my friends/colleagues going to work/study trip	0.465	
I prefer ride sharing with my family members going to work/study trip	0.456	
I prefer to change mean of transportation in case of traffic congestion	0.397	
Personality traits (PT)		
I am very keen to change my lifestyle with the change of income	0.513	0.59
I prefer to live near to my work/business/study place	0.448	
It is better for me to have a car	0.431	
Mode or mean of transportation affects my personality image	0.376	
Perceived behavioural control (PBC)		
Shorter travel time is the first priority	0.684	0.52
It disturbs me if I am forced to change in my routine due to others	0.557	
I avoid to interact with unknown people in travelling	0.391	
Intention		
I personally feel responsible to do not use/ reduce usage of private vehicle in future in order to reduce traffic congestion	0.635	0.73
I personally feel responsible to do not use/reduce usage of private vehicle in order to decrease negative effects on the environment	0.578	

Note: All the correlations were significant at $p < 0.01$ or 1%, α: Cronbach's alpha

5.4. ANALYSIS OF PERCEPTIONS TO TDM MEASURES

The comparative average response as shown in table 5-8 show that measure of advance traffic information has favourable evaluation from car and motorcycle users. All the groups almost have same intentions 'to participate in traffic education and awareness programs'. Tele-working measure has positive evaluation from public transport and non-motorized modes users, and office based transport service from public transport and car users. It implies that there is potential to provide tele-working opportunities and office based transport service for employees and workers. Car and motorcycle users have more willingness for use of better mode of public transport such as bus rapid transit or rail mass transit. This potential of private vehicle users can be utilized in order to make modal shift through provision of state of the art public transport. Non-auto groups have less willingness because they may think about high travel cost of new service. Motorcycle users have less whereas car and public transport users have more willingness 'to increase in parking charges at office sites for reduction of traffic congestion'. The willingness to pay road taxes for better traffic conditions, and increase in carbon tax on gasoline is less from non-auto users. This is obvious because they belong to low income category and during evaluation of fiscal strategies, they considered inflation and social impacts of increase. Table 5-9 present the results of TDM ranking that are based on overall average response and average response of four groups. The provision of advance traffic information in relieving the traffic congestion has obtained highest rank among all measures. The use of better mode of public transport is ranked as second. Measures of intention to participate in traffic education and awareness programs and to do tele-work are third and fourth in ranking respectively. The measure of intentions to participate in organization or institutional based transport service is ranked as fifth. Fiscal or push strategies have obtained low rank from all groups. Among fiscal measures, willingness to

Table 5-8: Average response of different groups to TDM measures

TDM Measures	Car	MC	PT	NMM	OA
Advance traffic information would be very helpful to relieve traffic congestion	3.43	3.40	3.31	3.38	3.36
I have intention to participate in traffic education and awareness programs	2.94	2.96	3.01	2.95	2.96
I have intentions to do online or tele-working if there will be an opportunity	2.84	2.79	2.65	2.71	2.75
I have intention to participate in office based transport service from organization/institutions	2.70	2.47	2.64	2.55	2.59
I would use public transport if there is better mode like rapid rail mass transit or bus lanes	3.23	3.30	3.13	2.90	3.20
I support to increase parking charges in order to reduce traffic congestion in the city	2.38	2.20	2.31	2.27	2.29
I support to put more carbon tax on gasoline in order to protect environment	2.68	2.57	2.40	2.45	2.52
I would pay more road taxes in order to improve traffic conditions in the city	2.83	2.74	2.56	2.57	2.71

Note: MC: motorcycle, PT: public transport, NMM: Non-motorized modes, OA: overall

Table 5-9: Ranking of TDM measures based on average response

TDM Measures	Overall	Car	Motorcycle	Public transport	Non-motorized modes	*Optimal ranking*
Advance traffic information	1st	1st	1st	1st	1st	***1st***
Public transport improvement	2nd	2nd	2nd	2nd	3rd	***2nd***
Education & awareness programs	3rd	3rd	3rd	3rd	2nd	***3rd***
Tele-work	4th	5th	5th	4th	4th	***4th***
Road tax	5th	4th	4th	6th	5th	***5th***
Office based transport service	6th	6th	7th	5th	6th	***6th***
Carbon tax on gasoline	7th	7th	6th	7th	7th	***7th***
Parking charges	8th	8th	8th	8th	8th	***8th***

Table 5-10: Rotated factor loadings for TDM measures

Latent Factors	**TDM measures**	**Factor loadings**	**α**
Soft measures	Advance traffic information would be very helpful to relieve traffic congestion	0.481	0.60
	I have intentions to participate in traffic education and awareness programs	0.425	
Pull measures	I have intentions to do online or tele-work if there will be an opportunity	0.623	0.54
	I have intentions to participate in organization/institution based transport service	0.551	
	Willingness to use better mode of public transport like rapid rail mass transit or bus rapid transit	0.478	
Push measures	I support to increase parking charges in order to reduce traffic congestion in the city	0.716	0.64
	I support to increase carbon tax on gasoline in order to protect environment from air pollution	0.515	
	Willingness to pay road taxes in order to improve traffic conditions in the city	0.373	

Note: all the correlations were significant at $p < 0.01$ or 1%, α: Cronbach's Alpha

pay road taxes has high rank in comparison to parking charges and carbon tax on gasoline. The measure to increase in parking charges has obtained lowest rank, because people feel that increase in parking charges in commercial areas would ultimately cause increase in the prices of goods. A confirmatory factor analysis was conducted to confirm the factors of selected TDM measures. Three factors were identified from selected TDM measures i.e. soft, pull and push measures. These results are presented in table 5-10.

5.5. STRUCTURAL EQUATION MODELING FOR EVALUATION OF PUBLIC ATTITUDES TOWARDS TDM MEASURES

The public attitudes towards TDM measures were modelled under the influence of extracted factors of lifestyles, attitudes, and intention. It has been hypothesized that extracted factors of lifestyles and attitudes are related differently with TDM measures directly or indirectly through intention as a mediating effect. This section includes two-step structural modelling. In first step, a separate structure for each category of TDM measures was constructed. In second step, a combined structural model of all three measures was constructed. At the end, regression estimates of structural equations for different mode users were estimated for only combined model in order to check heterogeneity among different mode users.

5.5.1. Structural model of psychological measures

The structural model as presented in figure 5-5(a) shows that personality traits (PT) are related negatively with intention, whereas travel attitudes (TA) and perceived behavioural control (PBC) related positively. It means people's intentions 'to do not use or reduce use' of private vehicle are affected negatively with the change of personality traits. It implies that people who have high preference for personality traits have less intention to reduce use of private vehicle for reduction of traffic congestion and environmental protection. On the other hand, congestion and community oriented travel attitudes and perceived control beliefs have positive impact on intention. It means people who have more concern about traffic congestion and community and strong control over behaviour possess more potential to reduce use of private vehicle. The acceptability of psychological or soft measures is significantly affected by intention, personality traits, travel attitudes, and perceived behavioural control. It is found that TA has direct influence on acceptability as well as mediating effect through intention. Seeking the recommendations for parameters of goodness-of-fit, it is said that this model has reasonably good fit in estimating the public attitudes towards psychological strategies as $\chi 2/DF < 5$, GFI > .90, AGFI and CFI > .90, CFI ≈ .90, RMR and RMSEA < .08.

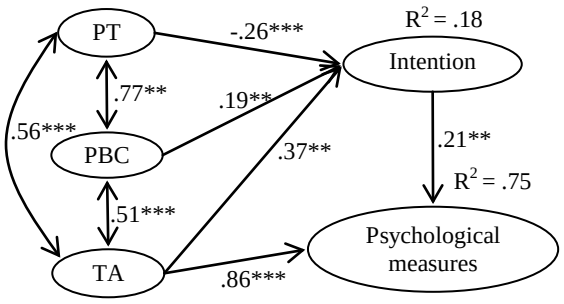
5.5.2. Structural model of pull measures

Figure 5-5(b) shows that TA and intention are related positively with people's attitudes towards tele-work, office/ campus based transport service and improved public transport. The PBC is found to have negative impact on acceptability of pull measures, which means people who possess less control over their behaviour have less potential to accept he pull measures. It depicts that people's personality traits, congestion and community oriented travel attitudes, and behavioural intentions have significant role in the anticipated use of these measures. Results imply that in order to enhance the potential of pull measures in mitigating traffic congestion and environmental problems, first people should have intentions for protection of environment and reduction of traffic congestion by reducing car use. The indices of parameters of goodness-of-fit are lying within

permissible limits; therefore, it is argued that this model has good fit in predicting the public attitudes towards pull measures.

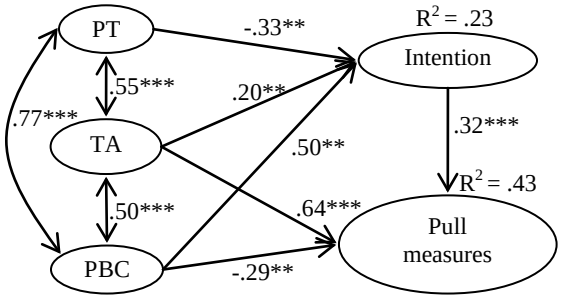
5.5.3. Structural model of push measures

The model of push measures as presented in figure 5-5(c) indicates that TA and PBC have significant direct influence on acceptability of push measures. The TA is positively related with the acceptability of push measures, whereas PBC negatively. It means the congestion and community oriented travel attitudes have positive association with the acceptability of fiscal measures, whereas perceived difficulties in changing and adjusting behaviour results low acceptability. It is argued that for better acceptance of push measures, first people should have intention of 'not using or reduce usage' of private vehicle for environmental and congestion reasons. The indices of parameters of goodness-of-fit are lying nearly within allowable limits. It is concluded that this model has good fit for estimation of public attitudes towards push measures.



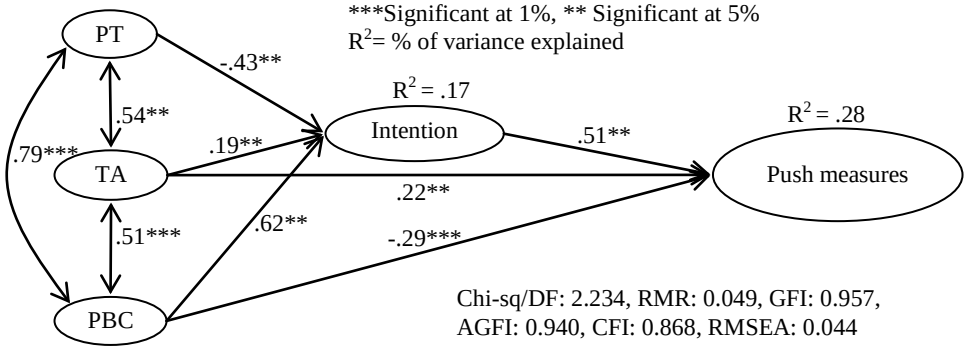
Chi-sq/DF: 2.448, RMR: 0.046, GFI: 0.956, AGFI: 0.938, CFI: 0.883, RMSEA: 0.048

(a) Model of psychological/ soft measures



Chi-sq/DF: 1.900, RMR: 0.043, GFI: 0.963, AGFI: 0.949, CFI: 0.885, RMSEA: 0.038

(b) Model of pull measures



Chi-sq/DF: 2.234, RMR: 0.049, GFI: 0.957, AGFI: 0.940, CFI: 0.868, RMSEA: 0.044

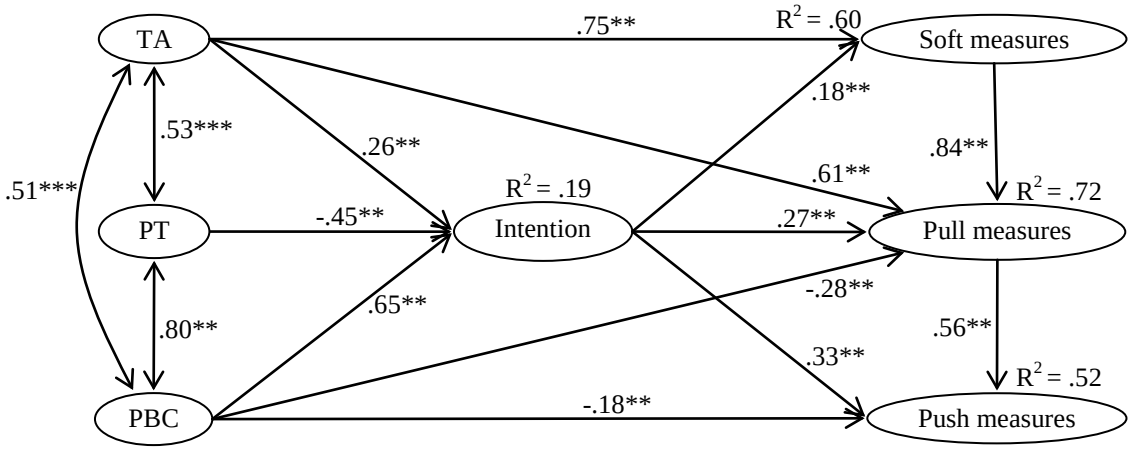
(c) Model of push measures

Figure 5-5: Structural model of psychological, pull and push measures

5.5.4. Combined structural model of all measures

The objective of this section is to construct a combined model of lifestyles, attitudes, intention and all TDM measures. This helps in understanding the interdependencies among different TDM measures and their influencing factors. The combined structural model in figure 5-6 shows that PBC has direct and indirect relationship with push and pull measures. However, the TA has direct relationship with psychological and pull measures. The PBC has negative influence on acceptability of pull and push measures that is same as results of separate models. This model predicts the significant interdependencies among TDM measures along with dependence on intention,

TA, PT, and PBC. This model tends to explain the process of consideration of TDM measures for practical implementation. As people, generally perceive psychological and pull measures more suitable to implement and push measure less suitable. From model results, it is implied that the acceptance of pull measures is dependent on integration of psychological measures e.g. traffic education and awareness programs, social marketing programs, etc. Similarly, acceptance of push measures is collectively influenced by integration of pull and psychological measures. It is argued that traffic information and traffic education and awareness programs need to initiate first in order to educate the public about traffic problems and alternative sustainable travel options. This model argues that pull measures should be implemented in advance of push measures. The indices of goodness-of-fit parameters are lying in the permissible limits, which indicate that this model has good fit in predicting the public attitudes towards TDM measures.



***Significant at 1%, ** Significant at 5%, R^2= % of variance explained

Chi-sq/DF: 2.383, RMR: 0.054, GFI: 0.936, AGFI: 0.917, CFI: 0.884, RMSEA: 0.047

Figure 5-6: Combined structural model of all TDM measures

5.5.5. Estimation of combined model parameters for different mode users

The combined model developed in previous section was used to make structural comparison among different mode users. Based on results as described in section of data collection, sample was divided into three categories in this section i.e. car oriented (204), motorcycle oriented (224) and green travellers (203) (public transport and non-motorized modes). This approach was adapted to make a comparative sample size among three groups. Only standardized estimates of structural equations and indices of goodness-of-fit parameters were compared. It was assumed that variability in indicators among three groups could be judged from structural equations and indices of goodness-of-fit parameters. The results of three structural models are presented in table 5-11. The signs of estimated structural equations of car user's model are same as model of figure 5-6. In case of motorcycle users model TA and PT have negative relationship with intention. The TA of motorcycle user's model also results negative impact on acceptability of pull measures. The signs of other structural parameters are same as overall model but significance of estimated parameters is less in comparison to car user's model. The relationship between PBC and pull strategies is positive in model of green travellers, which is opposite to overall model. Similarly, the relationship between intention and pull strategies has opposite sign to base model. By comparing results of separate models with the base

model in terms of signs of estimated parameters and their significance as well as indices of goodness-of-fit parameters, it can be said that the structural model of car users has good representation of overall public attitudes towards TDM strategies.

Table 5-11: Standardized estimates of structural equations for three models

Structural relationship/Co-relationships	Car users (N=204)	Motorcycle users (N=224)	Green travellers (N=203)
PT <- - -> TA	0.56**	0.43	0.58**
PT <- - -> PBC	0.86**	0.78**	0.71**
TA <- - -> PBC	0.54**	0.47	0.53**
PT - - - -> Intention	-0.85	-0.23	0.43**
TA - - - -> Intention	0.12	-0.67	-0.20
PBC - - - -> Intention	1.06	0.93	0.14
Intention - - - -> Soft measures	0.25**	0.29**	0.34**
Intention - - - -> Pull measures	0.52**	0.18	-0.12
Intention - - - -> Push measures	0.84**	0.34**	0.30**
TA - - - -> Soft measures	0.82**	0.79**	0.85**
TA - - - -> Pull measures	0.61**	-0.57	0.19
PBC - - - -> Pull measures	-0.37**	-0.39	0.28
PBC - - - -> Push measures	-0.41**	-0.17*	-0.29**
Soft measures - -> Pull measures	0.32	0.79**	0.69**
Pull measures - -> Push measures	0.29*	0.53	0.57**
Indices of goodness-of-fit parameters			
Chi-sq/DF	1.884	1.802	1.967
GFI	0.857	0.882	0.858
AGFI	0.834	0.846	0.816
CFI	0.715	0.717	0.711
RMR	0.084	0.077	0.088
RMSEA	0.066	0.060	0.069

Note: ** significant at 5% and * significant at 10%, N: number of samples in each group

5.6. SUMMARY OF FINDINGS

Results of public satisfaction with existing public transportation in Lahore, and public attitudes are presented in this chapter. Motorcycle is popular mode in middle income and young people group, and car in female and high-income group. Two types of travel behaviour exist in Lahore city i.e. private vehicle or auto dependent and captive behaviour. People belong to auto-dependent group have more tendency for shopping and recreation trips. Commuters are more satisfied with Daewoo bus service than wagon service and it has potential of reducing deficiency of public transportation system by making some improvements. Symbolic, functional, and cost and time factors are significant determinants of people satisfaction with selected modes and people perceived different modes differently.

Auto-oriented lifestyles and attitudes tend to reduce the use whereas transit factors tend to enhance the use of public transport. Public acceptability is higher for soft and pull measures compared to push measures. Travel attitudes, personality traits, and perceived behavioural control are underlying factors of people's intention to reduce use of private vehicle for environmental and congestion reasons, and collectively with intention of public attitudes towards TDM measures. Interdependencies exist between measures of different categories. Lifestyles and attitudes dimensions vary across different segments of mode users and model of car users has good representation of overall combined model of underlying factors and TDM measures.

Chapter 6

FACTORS INFLUENCING THE ACCEPTABILITY OF TDM MEASURES: APPLICATION OF BEHAVIOURAL THEORIES

This chapter presents the results regarding evaluation of factors influencing the acceptability of specific TDM measures using joint framework of theory of planned behaviour (TPB) and norm-activation model (NAM). The selected TDM measures in this chapter include public transport improvements, provision of office based transport service for employees and fiscal policy (100% increases in travel cost of private car by increasing vehicle ownership and usage taxes). The context of evaluation of measures and their influencing factors in this chapter is different from previous chapter. Here, the TDM measurers have been evaluated considering different scenarios or the TDM measures were presented to the respondents with some scenarios and condition in the questionnaire. In addition, questionnaire items related to lifestyles and attitudes were designed using the theoretical background of behavioural theories. Initially, factor analyses were conducted and a joint-structural-model of TPB and NAM factors developed. Then, this joint-model was used to construct the structure of acceptability for each measure. The details of questionnaire items related to analyses in this chapter are presented in part 1, 2, 3, and 6 of appendix C.

6.1. DISTRIBUTION OF RESPONDENT'S SOCIO-ECONOMIC CHARACTERISTICS OF

As mentioned in chapter three only 354 usable samples were obtained in this survey. The share of male and female respondents in sample is 68.4% and 31.6% respectively. The female respondents are less because they do not drive motorcycle, and share of working women is less in Lahore city. However, the share of female respondents is little higher than phase-I questionnaire survey. Almost 85% respondents are aged between 21-30 years, and only 47% have driving license. The detail of respondent's socio-economic characteristics is given in table 6-1.

Table 6-1: Distribution of respondent's socio-economic characteristics

Characteristics	Distribution (%)
Gender	Male (68.4), female (31.6)
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 drive	None (23.2), Motorcycle (43.2), Car (40.0)

Driving license	Yes (45.84), No (54.16)
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)

6.2. AVERAGE RESPONSE AND FACTOR ANALYSES

Average response and rotated factor loadings were estimated for respondent's perceptions to lifestyles, attitudes, norms, and behavioural intentions and response to selected TDM measures. These results are presented in next sub-section. The results of factor analyses were used to construct the joint structure of Theory of Planned Behaviour (TPB) and Norm-Activation Model (NAM), and separate structure of each TDM measure.

6.2.1. Rotated factor loadings for lifestyles, attitudes, and variable of TPB

A factor analysis was conducted, and five latent variables were identified based on theoretical background of TPB, and nature of various lifestyles and travel attitudes i.e. attitudes towards public transport (APT), subjective or social norms (SN), perceived behavioural control (PBC) over public transport, social status traits (SST), and perceived flexibility and freedom in travelling (PFF). These latent variables were defined as. *Attitudes towards public transport*: respondent's evaluation of selected positive attitudes towards public transport, *social or subjective norms*: respondent's propensity to use public transport under social pressure or sanctions for safety and environmental reasons, *perceived behavioural control over public transport*: respondent's control beliefs in using public transport due to certain constraints and limitations or respondent's beliefs on restricted freedom and flexibility in travelling in using public transport, *perceived freedom and flexibility*: respondent's beliefs on perceived freedom and flexibility of travelling modes such as private transport, and *social status traits*: respondent's consciousness for status, respect, and influence in the society. Cronbach's alpha values were also calculated for each factor in order to assess the reliability of factors and internal consistency in evaluation. Results of factor analysis and Cronbach's alpha values are presented in Table 6-2. The factor loadings for indicators of SN are near to .70 and alpha value for SN is .80, which indicates higher internal consistency in evaluating these observed variables. The factor loadings and mean scores for indicators of SN show that there are respondents who feel social pressure in using public transport. This is, because some people feel that public transport is safer specifically bus and minibus compared to motorcycle and auto-rickshaw, and it is less destructive to environment. These results argue that encouragement and appreciation from the society is important in enhancing the use of public transport. In second factor, i.e. attitudes towards public transport the factor loadings and mean value for "like to travel by public transport for reading newspaper and books, and interaction with other people" are higher than the economical and safer public transport. This may be due to presence of highly educated people in sample which implies that users friendly internal environment of public transport vehicle is much important than cheaper service for highly educated people. It can be argued that only cheaper service is not enough to attract such people. Talking about lower weight for safety parameter of public transport; in Lahore some people feel that private car is safer than public transport because they drive personally and carefully, and feel safe, whereas drivers of public transport vehicles especially Para-transit are not well educated, unskilled and drive disorderly. Therefore, they do not feel safe in using some mode of public transport e.g. Qingqi, wagon, and auto-rickshaw. It means education and skills of driver are much

important for ensuring safe riding, and motivating the people to use public transport. In perceived behavioural control (PBC) factor, higher mean value and factor loading for variable of perceived difficulty in using public transport indicate that most of the respondents feel that it is difficult for them to use public transport every time. It means the people's preferences among modes vary from situation to situation, and time to time. As most of the respondents are car and motorcycle users in modal share of study; therefore, they may or would prefer public transport only for some specific purposes or on some specific occasions e.g. travelling alone, unavailability of private vehicle at home and short distance trip etc. In PBC, the factor loadings for restricted freedom by public transport, and feel uncomfortable with unknown people are lower, which show less consistency in evaluation among respondents. Car ownership for status accounts much higher weight than wealth and social power as a guiding principle of life. It means the people own and use car not only for need but also for respect and status in the society. In the last factor, respondents placed higher weights for perceived flexibility and freedom in travelling of a travel mode in terms of route choice, and doing activities on the way going from/ to home. Results of last two factors implicate that people who have high positive beliefs on these factors may have low intentions to use improved public transport and other alternatives to private vehicle.

6.2.2. Rotated factor loadings for variables of NAM

The factor loadings were estimated for indicators of awareness of consequences (AC), ascription of responsibility (AR), personal norm (PN), and perceived feasibility of environmental protection (PFEP). These latent variables were defined as. *Awareness of consequences*: respondent's sense of awareness about the negative consequences of car related behaviour, *ascription or sense of responsibility*: respondent's sense of responsibility about the negative consequences of car related behaviour, *personal norm*: respondent's moral obligation for protection of ecosystem, and *perceived feasibility of environmental protection*: respondent's tendency to reduce use of private car, and buy an energy efficient vehicle for environmental protection. These results are presented in Table 6-2. In AC, the factor loadings vary from .601 to .713, which shows that there is significant internal consistency among respondents in evaluating the indicators of AC. This is also shown from Cronbach's alpha value i.e. .70. Regression weight of feeling joint responsibility for the consumption of natural resources is much higher than other two indicators of AR. Factor loading for feeling equally responsibility of traffic congestion caused by car use is lower because some people believe that disorder driving behaviour is also the reason of traffic congestion not only the use of car. Therefore, people who drive smoothly and mannerly feel less responsibility of traffic congestion caused by car use. However, such people also aware about the negative consequence of car use such as congestion and degradation of environment. People's moral obligations are high for preservation of natural resources compared to betterment of urban environment and society in personal norm factor. This may be due to shortage of gasoline and gas, and inflation in recent years. The factor loading for people's intentions to reduce use of car for environment protection is higher than willingness to buy an energy efficient vehicle in factor of perceived feasibility of environmental protection. This is, because some people perceived that the initial cost of these vehicle would be high and electricity is in shortage and may not be available everywhere. Nevertheless, this willingness potential can be enhanced by providing subsidies on such vehicle, and ensuring the availability of electricity.

Table 6-2: Rotated factor loadings for lifestyles, attitudes, norms, and control beliefs

Latent variable	Description of observed variables	M	Factor loading	α
Subjective/ Social norm (SN)	People who are important to me always encourage me to use public transport because it is safer	3.57	.695	.80
	If I use public transport, my friends and colleagues appreciate me because it is environmental friendly	3.68	.655	
Attitudes towards public transport (APT)	I like to travel by public transport because I can read newspaper and books	3.84	.804	.64
	I like to travel by public transport because I can interact with other people	3.58	.702	
	I like to travel by public transport because I feel more safe from accident	3.34	.431	
	I like to travel by public transport because it is economical	3.18	.334	
Perceived behavioural control (PBC) over public transport	For me, it is difficult to use public transport in everyday life	4.27	.808	.53
	If I use public transport only, I do/would feel restricted in travelling	4.16	.440	
	I feel uncomfortable being around unknown people in travelling	3.23	.372	
Social status traits (SST)	Having a car is a status symbol to me	3.80	.892	.60
	Social power is a guiding principle of my life	3.97	.572	
	Wealth is a guiding principle of my life	3.68	.429	
Perceived flexibility and freedom (PFF)	I prefer a mode of transport which gives flexibility in route choice	4.93	.536	.54
	I like a travel that allows me to do other acts on the way	4.49	.463	
	I think, car gives a lot of freedom in travelling	4.71	.344	
Travel schedule of family members does not give me enough freedom in travelling		3.06	---	---
Obeying religious and social values are important in travelling		4.75	---	---
Awareness of negative consequences of car use (AC)	Car usage causes shortage of scarce (rare) natural resources, e.g. oil & gas	4.61	.713	.70
	Excessive use of car deteriorates (destroys) the urban quality of life and environment	4.43	.637	
	Car usage is a major cause of traffic congestion	4.70	.601	
Ascription or sense of responsibility (AR)	I feel joint-responsibility for the consumption of natural resources such as oil and gas	4.43	.945	.71
	I feel equal responsibility for degradation of environment due to increase in traffic congestion	4.47	.645	
	I am/would equally responsible for traffic congestion caused by use of private car	4.27	.377	
Personal norm (PN)	I feel moral responsibility to preserve natural resources such as oil and gas	4.94	.949	.64
	I feel morally responsible for betterment of urban environment and society	4.83	.541	
Perceived feasibility of environmental protection	I feel that I can preserve environemnt by reducing car usage or not using car and I am ready to do	4.30	.530	.52
	To improve air quality, I am willing to buy and use an energy efficient vehicle, for example electric vehicle	4.79	.370	

Note: all questions were evaluated using six point ordinal scale i.e. strongly disagree, disagree, somewhat disagree, somewhat agree, agree, strongly agree. All the factor loadings were significant at 5, α: Cronbach's Alpha, M: Mean, '---'have no significant relationship with any factor.

6.2.3. Rotated factor loadings for behavioural intentions and response to TDM measures

The factor loadings were estimated for indicators of behavioural intentions and response to selected TDM measures. Two latent variables were defined for each TDM

measure. For public transport improvement measure, these are respondent's '*willingness to use*' improved public transport, and '*willingness to pay*' taxes for the improvement of public transport. For office based transport service measure, these latent variables are respondent's '*willingness to use*' this service, and '*willingness to support*' the provision of this service. For fiscal policy, these latent variables are termed as respondent's '*behavioural intentions*' to fiscal policy, and '*willingness to accept*' the double travel cost of car use. In general, latent variables of '*willingness to use'* improved public transport and office based transport service, and '*behavioural intentions'* to fiscal policy are referred as '*intention*' for purpose of structural equation modelling in next section. The results as presented in Table 6-3 show that factor loadings are much higher for indicators of support to office based transport policy, and willingness to use this service.

Table 6-3: Factor loadings for intentions and response to TDM measures

Policy Measures	Description of each scenario for evaluation	Mean score	Factor loading	α
Willingness to support policy [a]	For reduction of congestion	5.03	.843	.86
	For reduction of air pollution	5.06	.775	
Willingness to use transport service	I am willing to use it	4.35	.856	.82
	I am willing to use it because it will reduce travel cost	4.81	.813	
Willingness to use improved public transport	For reduction of traffic congestion	4.70	.892	.88
	For reduction of air pollution	4.78	.839	
	If public transport is more reliable than car	4.75	.783	
	For less travel cost as compared to car	4.68	.666	
	For shorter travel time as compared to car	4.44	.518	
Willingness to pay taxes for the improvement of public transport	For reduction of traffic congestion	4.13	.826	.93
	For reduction of air pollution	4.33	.818	
	If public transport is more reliable than car	4.20	.813	
	For less travel cost as compared to car	4.26	.802	
	For shorter travel time as compared to car	4.07	.727	
Willingness to accept fiscal measures	For reduction of congestion	3.76	.844	.86
	For reduction of air pollution	3.94	.901	
	If collected charges/taxes use to improve public transport	4.20	.697	
Intentions to fiscal measures	I would travel by car as usual (scale was reversed)	3.43	.476	.74
	I would travel less by car	3.67	.598	
	I would prefer to travel by improved public transport	3.82	.867	
	I would travel with car by sharing travel cost with friends	3.91	.464	
	I would prefer to use available office/campus transport	4.54	.562	

Note: a policy related to office based transport service, all questions were evaluated using six point ordinal scale i.e. strongly disagree, disagree, somewhat disagree, somewhat agree, agree, strongly agree. All the factor loadings were significant at 5%, α: Cronbach's Alpha

For willingness to use improved public transport and pay taxes for the improvement, the factor loadings for reduction in traffic congestion and air pollution are higher as compared to reliable service, less travel cost and shorter travel time. It implies that people have more concern about traffic congestion and air pollution in the city, and such people have more potential to use improved public transport. Results also depict that only cheaper public transport service is not enough to attract private vehicle users. A good environmental friendly public transport service is required which should be capable to reduce traffic congestion by attracting private vehicle users. Ultimately, this would help in reducing travel time and cost, and improving the reliability of public transportation system. Similarly, the factor loadings are higher for reduction of traffic congestion and air pollution in willingness to accept fiscal policy; however, average response is higher for 'if collected taxes use to improve public transport'. These results argue that public

acceptance of fiscal measures can be enhanced by ensuring proper usage of collected taxes or charges to public. Overall internal consistency is also much higher for willingness to accept fiscal policy i.e. alpha =.862. In case of behavioural intentions to fiscal policy, respondent's preferences to use available office/campus transport (mean = 4.54) is higher than others. However, the factor loading is much higher for improved public transport compared to other alternatives. It means most of the respondents have same preferences for use of improved public transport in response to implementation of fiscal policy.

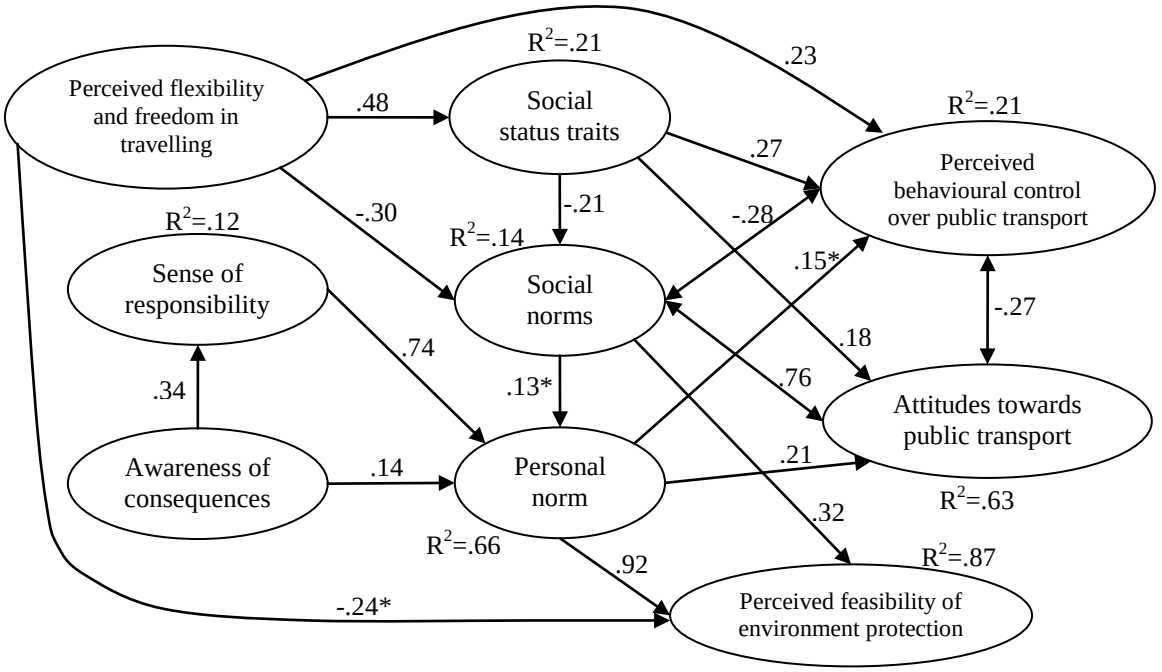
6.3. STRUCTURAL EQUATION MODELING

Initially, joint-structural-model (JSM) of TPB, NAM and three additional variables was developed to evaluate the interdependencies between TPB and NAM. Later on, this joint model was used to evaluate the influence of latent variables on behavioural intentions and response to policy measures. In contrast to TPB theory, it was assumed that personal norm has direct influence on behavioural intentions instead of social norms as followed in previous researches (Bamberg *et al.* 2007 and 2011, Bamberg and Moser, 2007). Some significant variables of personal information were also introduced in developing structural model of policy measures. These variables were coded as dummies from measured data for structural equation modelling and included: 1 if marital status is single otherwise 0, 1 if personal income is greater than 40,000 PKR (Pakistan Rupees) otherwise 0, 1 if occupation is civil employee otherwise 0, 1 if use car otherwise 0, and 1 if use public transport otherwise 0.

6.3.1. Joint-Structural-Model (JSM) of TPB and NAM

It is assumed that social status traits (SST) and perceived flexibility and freedom (PFF) in travelling affect the people's attitudes towards public transport (APT), subjective or social norms (SN), and perceived behavioural control over public transport (PBC). It is also assumed that perceived flexibility and freedom in travelling has direct relationship with perceived feasibility of environmental protection by reducing car use and buying an energy efficient vehicle. Initially, correlations were estimated among three latent variables of TPB as presented in figure 6-1. Results indicate that SN and APT are strongly correlated with each other. However, correlations of PBC with SN and APT are negative which indicate that people who believe on perceived difficulty and restricted freedom in using public transport have less positive attitudes towards public transport and also feel less social sanctions in using public transport. The proposed joint-structural-model (JST) with three additional variables on lifestyles and intentions depicts that SST has significant positive relationships with APT and PBC, whereas negative with SN. It means the respondents who have positive beliefs on social status factors also have positive evaluation of selected attitudes towards public transport. However, such respondents also believe on restricted flexibility and freedom in travelling by using public transport. The negative relationship between SST and SN argues that respondents belonging to upper status class feel less social pressure in using public transport. Similarly, PFF has significant direct relationship with PBC and SN. The significance between PFF and APT was not determined from the modelling. The negative relationship between SN and PFF depicts that those who believe on flexibility and freedom in travelling have less social sanctions in using public transport. The respondents who believe on perceived freedom and flexibility of travel mode also have positive beliefs on restricted freedom and flexibility in using public transport. It means such auto-oriented

factors tend to decrease the use of public transportation. Similarly, respondents who have positive attitudes on social status traits do feel that use of public transport tends to decrease their freedom and flexibility in travelling. The eco-friendly personal norm is positively affected by people's awareness and sense of responsibility about the negative consequences of car use. The PN and perceived feasibility of protecting environment are strongly related with each other. This depicts that people's personal norm for protecting the ecosystem is highly important for reduction of car use and willingness to buy an energy efficient vehicle. The PFF has negative impact on people's intentions to protect environment. It argues that perceived freedom and flexibility of auto modes tend to reduce the propensity of car use reduction and willingness to buy an energy efficient vehicle for environmental protection. In other words, it can be said that car use reduction and buying of energy efficient vehicle tend to reduce people's flexibility and freedom in travelling. The positive relationship of PN with APT indicates that some respondents who have positive evaluation of eco-friendly norms also possess positive attitudes towards public transport usage. It means such eco-friendly personal norms are important for activation of people's positive attitudes towards public transport. The positive relationship between SN and PFEP depicts that pressure and motivation from the society to use public transport are important for reduction of car use, and motivation of people to buy an energy efficient vehicle. Most of the structural relationships in figure 6-1 were significant at 5% level of significance. Seeking the recommendations it is said that this joint model has reasonably good fit in estimating the respondent's perceptions as $\chi 2/DF < 5$, GFI ≈ .90, AGFI and CFI are approaching to .90, and RMSEA < .08.



Chi-sq/ DF = 2.338, GFI = .892, AGFI = .861, CFI= .858, RMSEA = .062, *Significant at 10%, R^2= % of variance explained, double headed arrows = correlations

Figure 6-1: Joint structural model of variables of TPB, NAM and additional variables of lifestyles and attitudes

6.3.2. Structure of public transport improvement measure

It has been hypothesized that people's willingness to pay taxes for the improvement of public transport is affected by their willingness to use improved public transport. The constructed joint structural model in previous section was used to construct structural model of public transport improvement measure. Modelling results as presented in Table 6-4 show that APT and PN have positive relationship with respondent's willingness to use improved public transport. It means in order to enhance use of improved public transport, first people must feel moral obligation of preserving ecosystem and second they should also have positive attitudes towards public transport. However, willingness to use is negatively affected by people's perceived behavioural control over public transport. This argues that people who have high belief on freedom and flexibility of auto transport have low potential to use improved public transport. Personal income has negative impact on people's behavioural intentions to improved public transport. Current car users also have low willingness to use as its relationship is negative with behavioural intentions. However, civil employees and single respondents have more tendencies to use. It means people who travel alone have more potential of using public transport compared to travelling with female family members or even with friends. Because some people feel comfortable and secure on private transport while travelling with female family members, and also feel good on private transport while travel with friends. The structural relationship between willingness to use and willingness to pay is positive and highly significant. By comparing the values of goodness of fit parameters with recommended values, it can be said that this model has moderate fit in estimating the public attitudes towards public transport improvement measure.

6.3.3. Structure of office based transport service measure

In this study it is assumed that office based transport service somewhat has nature of public transport, and transit oriented attitudes and factors may have significant relationship with people behavioural intentions to this measure. Structural modelling results as presented in Table 6-4 reveal that public transport oriented attitudes and eco-friendly personal norm have positive relationship with support to policy, and willingness to use. However, respondent's perceived behavioural control over public transport has negative impact on people's willingness to use this service. It can be argued that people perceive such service in same manner as public transport. They feel that use of such service would limit their freedom and flexibility in travelling. Personal income has negative impact on people's behavioural intentions. Similar to public transport strategy, single respondents and civil employees have more willingness to use such transport service. The structural relationship between willingness to use and support to policy is positive and highly significant. By comparing the values of parameters of goodness of fit with recommended values, it can be said that this model has reasonable fit in estimating the respondent's intentions towards this measure.

6.3.4. Structure of fiscal policy

The term "fiscal policy" in this chapter describes the combination of all economic measures related to use of private car. Structural model was developed for acceptability of fiscal policy measure using JSM as developed in previous section. Behavioural intentions to fiscal policy were defined as "travel by car as usual, travel less by car, travel by improved public transport, travel on car by sharing cost with friends and travel on available office/campus transport. Results of this model as presented in Table 6-4 depict that SST has significant influence on people's intentions to fiscal policy and willingness

to accept 100% increase in travel cost of car use. This relationship is negative with behavioural intentions but positive with willingness to accept double travel cost of car use. It depicts that those respondents who have positive beliefs on social status traits would be ready to accept double travel cost of car use, and may reject the alternative travel options to car. The PBC has negative relationship with behavioural intentions, whereas positive with willingness to accept fiscal policy. This implies that people having high beliefs on restricted freedom and flexibility in using public transport would reject the alternatives to car, and may accept double travel cost of car usage. Personal norm and attitudes towards public transport have positive relationships to behavioural intentions and willingness to accept fiscal policy. The structural relationship between behavioural intentions and willingness to accept fiscal policy is positive and highly significant. Personal income has negative impact on behavioural intentions to policy. Current car users also have negative attitudes towards behavioural intentions. However, positive relationship of public transport users with behavioural intentions reveals that potential car users such as current public transport and motorcycle users are highly influenced group of this policy. It can be argued that these groups can be restricted from car ownership and usage by increasing the travel cost of car use, and providing the alternative travel options to car. These alternatives include public transport improvement, office based transport services for employees and workers, and provision of ride sharing programs. The values of goodness of fit parameters indicate that this model also has reasonable fit in estimating the public attitudes towards fiscal policy.

Table 6-4: Standardized estimates of structural equations for TDM measures

	Public transport Improvement		**Office based transport service**		**Fiscal measures**	
Latent variables	Willingness to use (Intention)	Willingness to pay	Willingness to use (Intention)	Willingness to support policy	Intention to policy	Willingness to accept
Attitudes towards public transport	0.14	---	0.16	0.13	0.24	0.17
Perceived behavioural control over public transport	-0.28	---	-0.17	---	-0.13	0.15
Personal norm	0.40	---	0.12	0.32	0.21	0.24
Social status traits	---	---	---	---	-0.16	0.19
Intention	---	0.60	---	0.53	---	0.36
Observed variables of personal information						
Personal income	-.019	---	-0.29	---	-0.13	---
Marital status	0.16	---	0.20	---	---	---
Car users	-0.11	---	---	---	-0.14	---
Public transport users	---	---	---	---	0.23	---
Civil employees	0.13	---	0.19	---	---	---
Indices of goodness of fit parameters						
R^2	0.24	0.36	0.23	0.55	0.26	0.32
Chi-sq/ DF	2.545		2.099		2.346	
GFI	0.846		0.874		0.850	
AGFI	0.825		0.835		0.819	
CFI	0.838		0.848		0.836	
RMSEA	0.066		0.056		0.062	

Note: all structural relationships were significant at 5%,; --- relationships were not assumed or determined. R^2= % of variance explained.

6.4. SUMMARY OF FINDINGS

This chapter presented the results of factors influencing the acceptability of public transport improvement, office based transport service, and fiscal TDM measures considering lifestyles, travel attitudes, and conceptual framework of TPB and NAM. It is found that behavioural theories can be used as frame of reference in developing countries for design of questionnaire in evaluating the intentions of specific market segment. Social status oriented, and auto oriented factors such as freedom and flexibility in travelling have significant influence on people attitudes towards public transport, perceived behavioural control over public transport and social or subjective norms. These factors tend to reduce the potential usage of public transport. The PN, SN, and PFF have significant effect on people's intentions to protect environment from negative impact of car use. The APT, PBC, and PN are significant determinants of behavioural intentions to TDM polices. APT and PN have positive influence whereas PBC has negative on behavioural intentions. In socio-economic characteristics personal income, marital status, and existing travel mode are also significant in determining the behavioural intentions. It is found that high income and status conscious people as well as who have high belief on freedom and flexibility of auto transport may reject the alternatives to car, and accept the policy of doubling travel cost of car use. Modelling results also reveal that policy of doubling the travel cost of car use would help in restricting the public transport users and potential car users from owning and using the car. It means this policy would help in keeping the existing public transport users to continue to use, and to attract the potential users such as middle-income people even if it does not have significant impact on travel behaviour of car users.

Chapter 7

FACTORS INFLUENCING THE COMMUTER'S ATTITUDES TOWARDS PUBLIC AND PRIVATE TRANSPORTATION MODES

After evaluation of influencing factors on acceptability of TDM measures in previous chapter, this chapter describes the results of commuter's attitudes towards transportation modes considering attitudinal aspects of private car and public transport, situational factors, mobility restrictions and incentives, and moral obligations. It aims to combine improved public transport policy with mobility restrictions on car use, and evaluate how people's intentions change under different situations, restrictions, and incentives. First part of this chapter describes the results of questionnaire based survey and structural equation modelling for people's intentions to use private car or improved public transport. Figure 7-1 shows a hypothetical framework of this analysis and details of questionnaire items related to this analysis are given in part 4 and 5 of appendix C. This part also elaborates the policy variables for public transport improvement, and measures for making effective use of improved public transport. In second part of chapter, results of detailed interviews are presented. The objective of detailed interviews is to verify or clarify the findings of two questionnaire surveys as presented in previous two chapters and first part of this chapter. These interviews include following items advantages and disadvantages in using existing mode, reasons of not using other modes, perceptions to desired service quality level of public transport and use of public transport under fiscal restrictions on use of private vehicle, and intentions to use office based transport service.

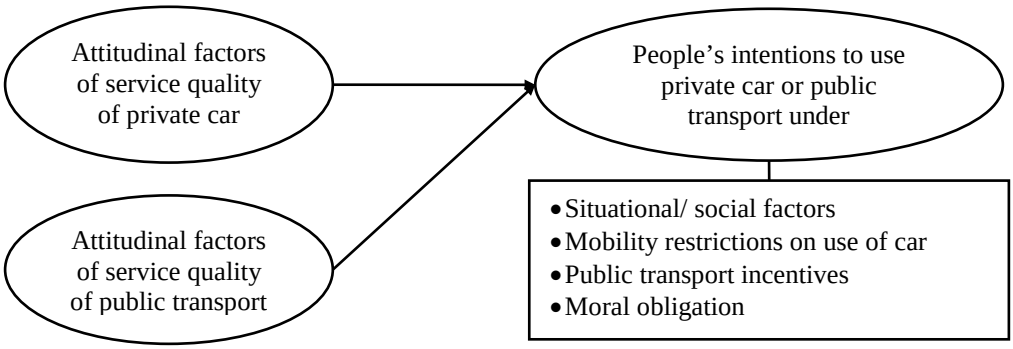


Figure 7-1: A hypothetical framework of structural equation modelling

7.1. AVERAGE RESPONSE AND FACTOR ANALYSIS

7.1.1. Intentions to use public transport under stated conditions

Initially, average response was calculated for respondent's preferences to use public transportation and private under stated factors and conditions. For this purpose, respondent's response was coded on bipolar scale i.e. -2 (absolutely use car), -1 (usually

car but also accept public transport for sometimes), 0 (both car and public transport as per situation), 1 (usually public transport but not every time) and 2 (absolutely use public transport). The factor loadings and Cronbach's alpha values for each defined latent factor were also estimated. Results of factor analysis are presented in table 7-1. It is indicated from results as presented in table 7-1 that under different situational constraints respondent's preferences vary i.e. preferences to use public transportation are more when they commute alone and with friends compared to other scenarios. Travelling with family members accounts less average response for public transport. It can be said that people feel insecure and less privacy while travelling with family members especially with female. The factor loadings for commuting with family members are also more compared with travelling alone and friends that indicate higher internal consistency among respondents in evaluating these indicators. As most of the respondents belong to high education class; therefore, such people may have more concern about privacy and security matters.

Table 7-1: Results of average response and rotated factor loadings for public transport usage under factors, incentives and restrictions

Description of items	Mean	Factor loadings	α
Situational/ social factors (SFs)			
Commuting with family members	-1.08	.887	.82
Travelling with elder family members	-1.23	.827	
Commuting with friends	-.427	.627	
Commuting alone	-.412	.567	
Acceptability of mobility restrictions on car use (AMR)			
When you need to pay road tax Rs.100 for use of car	.429	.814	.85
When you need to pay Rs. 100 parking fee at destination	.350	.800	
Parking is far from destination	.226	.704	
When entry of car is restricted in public transport service area	.673	.665	
When parking is limited at destination	.121	.647	
Acceptability of public transport incentives (APTI)			
If public transport is reliable than car	.517	.837	.90
When travel cost by public transport is half of car	.412	.832	
When travel time by public transport is 10 minutes less than car travel time	.263	.812	
When seat is assured in public transport with same travel time as car	.146	.757	
When seat is assured in public transport with same travel cost as car	-.008	.706	
When you can directly access many important places by public transport	.576	.697	
Moral Obligation (MO)			
to preserve natural resources e.g. oil & gas	.771	.873	.83
to protect environment from air pollution by reducing car use	.735	.847	
to reduce traffic congestion by reducing car use	.573	.593	

Note: All the factor loadings were significant at $p < .05$ or 5%, α: Cronbach's Alpha

In mobility restrictions on car 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 traffic congestion in highly congested areas. Parking charges and road tax on car use have almost same influence on car use reduction. The factor loadings for fiscal restrictions on

car use are high i.e. near to .80, which shows that most of the respondents perceived these restrictions equally. Limited and far parking have less influence on car use reduction. This may be due to excessive availability of parking facilities in most of commercial and business areas. However, imposition of parking charges has significant influence on travel preferences of these people.

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 importance in defining the service quality level of public transport for target group of people. However, importance of sitting depends on length of trip and class of travellers. With same travel cost and time, people may prefer their private vehicle even with assurance of seat, however; people's preferences may be different if travel cost and time are less. The factor loadings are higher for reliability, less travel cost and shorter travel time, and more than .80, which shows high consistency among respondents in evaluating these variables. The factor loadings for direct access is lower because some respondents may feel that it is difficult to have such public transport service that can provide direct access to every destination. Results of average response and factor loadings depict that moral obligations are high for reduction in air pollution and preserving natural resource compared to reduction in traffic congestion by reducing car use. It means that people have more concern for air pollution and natural resources than traffic congestion caused by their own behaviour. This may be due to increase in air pollution from transport sector that causes health problems and shortage of fuels as well as increase in fuel prices in recent years. Moreover, they may feel that these issues are more serious than traffic congestion and need to be cured.

More than 70% times respondents preferred BRT to Daewoo bus service under all stated conditions and factors whenever they selected alternative two to fine. It means people want a congestion free and rapid transit service in Lahore, and if such service is provided then they prefer to use whenever they need to use or they restricted to use private transport by imposing fiscal measures and other mobility restrictions.

7.1.2. Factor analysis for attitudes on service quality attributes of public transport and private car

A factor analysis was conducted to identify the factors for respondent's attitudes on service quality attributes of public transport and private car. Three factors were identified based on Eigen value greater than 1. These factors were named considering the tendencies associated with attributes from user's perspective i.e. instrumental attributes (IA), social/ aesthetic orderliness (SO/AO), and personal orderliness (PO). Attributes with higher factor loadings are highly influential in explaining the extracted factors. The attributes with factor loading of 0.4 or higher are only reported in table 7-2. The instrumental attitudinal aspects consisted of functional features of private car and public transport such as convenience, comfort, reliability, and safety. Social/ aesthetic orderliness attitudinal aspects include elegant, respect, health, calmness, social value, environmental impact, and exciting. Similarly, third factor personal orderliness includes attributes relating to privacy, and friendly environment of vehicle. These three factors explain 49.59% and 44.71% of the total variance for public transport and private car respectively. Moreover, reliability of the factors can be seen from the Cronbach's alpha value that the internal consistency among respondents in evaluation is relatively good. These extracted factors were used to evaluate their influence on behavioural intentions towards public transport under stated restrictions as mentioned in table 7-2. Average score was calculated for each factor using respondent's response on bipolar scale. All the factor loadings were significant at $p < .05$.

Table 7-2: Rotated factor loadings for attitudinal aspects of public transport and private car

Attitudinal attributes	Social/ aesthetic orderliness	Instrumental attributes	Personal orderliness
Public transport			
Elegant	0.773		
Relaxed	0.747		
Healthy	0.747		
Respectable	0.700		
High social value	0.698		
Exciting	0.630		
Environmental friendly	0.617		
Attractive	0.569		
Calm	0.547		
Comfortable		0.771	
Convenient		0.680	
Reliable		0.673	
Safe		0.495	
Fast		0.425	
Personal			0.762
Friendly			0.463
Un-crowded			0.452
Cronbach's Alpha	0.913	0.825	0.524
Factor average	-0.606	-0.527	-1.01
% of variance explained	26.78	16.25	6.56
Private car			
Elegant	0.740		
Respectable	0.656		
Exciting	0.622		
High social value	0.603		
Relaxed	0.586		
Healthy	0.552		
Fast	0.479		
Advance	0.439		
Calm	0.421		
Reliable		0.659	
Comfortable		0.644	
Convenient		0.533	
Attractive		0.433	
Safe		0.427	
Personal			0.710
Un-crowded			0.685
Friendly			0.523
Cronbach's Alpha	0.877	0.766	0.683
Factor average	1.20	1.238	0.928
% of variance explained	19.57	13.63	11.51

7.2. STRUCTURAL EQUATION MODELING OF COMMUTER'S PREFERENCES TOWARDS PUBLIC TRANSPORTATION

Structural models were developed using the results of factor analysis on service quality attitudes, and perceptions to use private car and public transport. For SEM purpose preferences to use are categorized into four latent variables deeming the nature of different factors i.e. situational factors (SF), acceptability of mobility restrictions on car use (AMR), acceptability of public transport incentives (APTI), and moral obligations (MO). In this section, mainly the influence of attitudinal aspects of both modes is interpreted in terms of commuter's preferences to use public transportation under stated conditions and restrictions. Figure 7-2 presents a typical framework of structural equation modelling for people's preferences to use public transport.

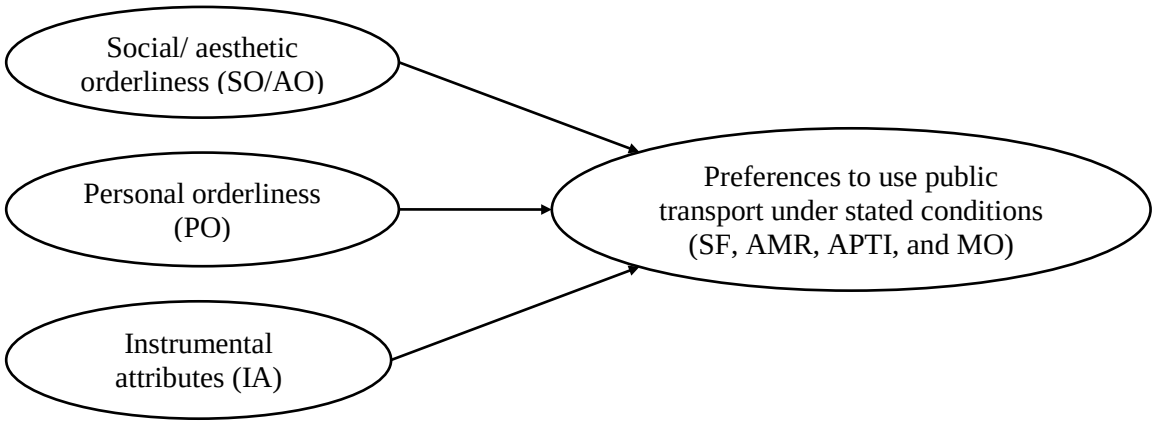


Figure 7-2: A typical structure of structural equations

7.2.1. Structures of preference with attitudinal factors of public transport

The models parameters were estimated for each latent dependent variable separately using extracted attitudinal factors of public transport. SEM results as presented in table 7-3 depict that people's attitudes on social/ aesthetics and personal orderliness of public transport have significant and positive relationships with people's preferences to use public transport under situational factors. It means the respondents who have negative attitudes on social and personal dimensions of public transport also have low preferences to use it under SFs. Attitudes on instrumental attributes of public transport have positive influence on public transport usage under mobility restrictions on car use. It can be argued that improvement in instrumental dimensions of public transport along with mobility restrictions on car would help in enhancing the use of public transport. Social/ aesthetics and personal orderliness have significant and positive relationship with public transport incentives. These results imply that improvement in social and personal dimensions of public transport together with instrumental incentives would help in improving the image as well as use of public transport. The significant structural relationship between moral obligation and personal orderliness is negative which depicts that people feel moral obligation in using public transport for environmental protection, preservation of resources, and reduction of traffic congestion even they possess negative attitudes on personal dimensions of public transport. Positive relationship between instrumental factors and moral obligation implies that improvement in functional features of public transport has positive impact on activating the moral obligation of people for the use of public transport or reducing the use of car.

7.2.2. Structures of preference with attitudinal factors of private car

Structural models for public transport usage with extracted attitudinal factors of private car show that attitudes on personal and instrumental attributes have negative effect on public transport usage under situational constraints. It means people who have high positive attitudes on personal and instrumental dimensions also have low preferences to use public transport under situational factors. It can be argued that people do/would prefer to use private car while travelling with family members due to privacy and security matters. Considering the cases of mobility restrictions on private car and public transport incentives, social/aesthetics orderliness of private car have significant and negative relationship with preference to use public transport. It shows that the strong attitudes on social/aesthetics dimensions result negative influence on acceptability of mobility restrictions on car use and public transport incentives. However, mobility restrictions and public transport incentives are little effective in changing the behavioural intentions even respondents have positive attitudes on instrumental attributes of private car as these relationships are positive. From these results, it can be said that social and aesthetics dimensions of private car are more decisive factors than instrumental dimensions. Similarly, respondents who have positive attitudes on social/aesthetics dimensions of private car feel moral obligations less in using public transport. Nevertheless, relationship of personal and instrumental attitudes is positive with respondent's moral obligations. It means there are some people who have positive beliefs on these dimensions also feel moral obligation in using public transport or reducing the use of car.

By comparing the value of goodness-of-fit parameters with permitted limits, it is argued that the developed models have reasonable fit in estimating the respondent's attitudes and preferences.

Table 7-3: Standardized estimates of people's preferences to use public transport

Structural equations and indices of goodness of fit parameters	Situational factors	Acceptability of mobility restrictions	Acceptability of public transport incentives	Moral obligation
Public transport				
Social/ aesthetic orderliness	0.34**	0.06	0.23*	0.11
Personal orderliness	0.23**	0.08	0.14*	-0.28**
Instrumental attributes	0.10	0.27*	0.13	0.15*
Chi-sq/DF	2.73	2.60	2.38	2.84
RMR	0.077	0.079	0.080	0.088
GFI	0.881	0.877	0.883	0.884
AGFI	0.850	0.847	0.885	0.851
CFI	0.910	0.910	0.925	0.912
RMSEA	0.070	0.068	0.063	0.072
Private car				
Social/ aesthetic orderliness	-0.12	-0.21*	-0.29*	-0.21*
Personal orderliness	-0.22*	-0.06	-0.07	0.24**
Instrumental attributes	-0.23*	0.16*	0.15	0.17*
Chi-sq/DF	2.99	2.84	2.475	3.06
RMR	0.078	0.077	0.076	0.081
GFI	0.887	0.884	0.894	0.892
AGFI	0.853	0.851	0.866	0.857
CFI	0.897	0.898	0.821	0.903
RMSEA	0.075	0.072	0.065	0.076

Note: ** Significant at 5 % and * Significant at 10%

7.3. RESULTS OF DETAILED INTERVIEWS WITH PUBLIC TRANSPORT, CAR AND MOTORCYCLE USERS

7.3.1. Distribution of personal information of interviewees

A low response rate was observed due to busy schedule of employees. Therefore, only 42 samples were obtained which included 14 private car and auto-rickshaw users, 15 motorcycle and auto-rickshaw users and 13 public transport and non-motorized modes users. Some interviewees totally use one mode whereas some use two modes such as sometimes-private car and sometimes auto-rickshaw. The sample size is small due to low response rate. However, some important inferences can be made from the response of obtained samples that can be helpful in policymaking. It was assured to get suitable number of female respondents in each mode category. However, there are only two female in motorcycle users group because they do not drive motorcycle and only travel as a passenger. The share of female respondents in private car and public transport groups is much better. The detail of sampling and respondent's personal characteristics is given in table 7-4.

Table 7-4: Distribution of respondent's personal information

Description of items		Car and auto-rickshaw	Motorcycle and auto-rickshaw	Public transport and NMM
	Number of samples	14	15	13
Gender	Male	7	13	9
	Female	7	2	6
Status	Single	9	8	10
	Married	5	7	3
Age (years)	21-30	7	9	6
	31-40	4	3	4
	> 40	3	3	3
Education	High school	--	1	2
	Secondary school	--	1	3
	Bachelor	5	5	6
	Master and higher	9	8	2
Occupation	Student	--	--	4
	Civil employee	11	12	6
	Private employee	3	2	2
	Business	--	1	1
Personal income (PKR)	below 10,000	--	--	5
	11,000-20,000	--	7	4
	21,000-30,000	1	2	2
	31,000-40,000	3	2	2
	41,000-60,000	6	2	--
	More than 60,000	4	2	--
Household income (PKR)	below 20,000	--	--	6
	21,000-30,000	--	6	3
	31,000-40,000	--	2	2
	41,000-60,000	1	3	1
	More than 60,000	13	4	1
Vehicle ownership	Motorcycle	--	15	5
	Car	12	--	2
Driving License	Yes	9	7	4

The numbers of respondents are high in age group of 21-30 years in all three groups. Interviews results show that the education level of auto users is much higher from public transport users. This is, because these two groups mainly belong to middle and high-income category, and education level in Lahore increases with the increase of household income. The people who belong to middle and high-income group have more potential of getting higher education than low-income group. Most of the interviewees in private car and motorcycle groups are employees whereas four are students in public transport group. The purpose of including students is to get opinion of potential motorcycle and car users. These students belong to engineering class and have high potential of owning motorcycle and car in future after graduation.

7.3.2. Merits and demerits of using existing modes

This section elaborates the merits and demerits of using existing travel mode and results are presented in figure 7-3. Some interesting remarks from respondents are also given in next sub-sections.

7.3.2.1. Private car and auto-rickshaw users

Results of interviews as presented in figure 7-3 reveal that convenience, freedom, flexibility, comfort, reliability and time saving are the main motives in the use of private car and auto-rickshaw. One female remark about daily travelling "my father use car and brother motorcycle whereas I use auto-rickshaw because their routes are different and I cannot travel alone on public transport. My father dropped me at university route stop when I was student. Generally, I do not feel comfortable while travelling in public transport even with low fare". The other common merits include status symbol, personality and image in the society, presence of other workers and students in house, family restrictions (some female in some families have restrictions on travelling alone), health, and air pollution. Some car users said, "*Travel distance and traffic congestion also have some impact on their travel behaviour*". Religious values are secondary matters, and importance varies from family to family or person to person. One female gave a very interesting remark 'when I go on party I care about my personality and social status because people judge about your personality from your mean of travelling'. However, one car user said social status and personality does not matter in travelling even I do not use public transport. The main disadvantages in using car are traffic congestion, disorder driving behaviour, hectic and long driving, limited and far parking, and vehicle maintenance. Some remarks of car and auto-rickshaw users are given below.

I am doing master with job; therefore, it is very difficult to travel on public transport.
I prefer auto-rickshaw when car is not available at home (most female).
I use private car irrespective of travel distance; however, limited and far parking have effects on choosing mode or destination of travel especially for shopping trip.
I need to drop children at school, and go for shopping and part time work on the way; therefore, it is difficult to use public transport.
I drop my father at his work place, but he uses auto-rickshaw if his schedule is different from my schedule.
When I was student, I used campus transport, now I use private car due to flexibility in job schedule,. (One female)
I choose only those shopping place that have sufficient parking place (people prefer to go hyper-star super market store because of parking availability).

Driving is a responsibility; it is not an easy task, and use of public transport is healthy.

7.3.2.2. Private motorcycle and auto-rickshaw users

Time saving, low travel cost, safety (use of helmet) and security, convenience and flexibility, social status and personality (excluding 2 respondents), reliability of arrival time in office, traffic congestion and travel distance are the important factors which motorcycle users consider in their travelling. The religious and social values have importance in long travelling. Travel schedule and pattern of family members affect the mode choice in some cases. Some motorcycle users mentioned that they try to take shortest route, avoid longer traffic signal and travelling in rush hour and keep away from the heavy traffic. The major disadvantages in using motorcycle include female cannot drive, highly unsafe (high chance of accident), no protection from bad and severe weather and air pollution, uncomfortable and uneconomical for long distance travelling, health problems due to exposure to air pollution, and vehicle maintenance. Some interesting comments are listed below.

I use motorcycle because it has become trend. Whenever I use bicycle people make joke at me..
Even in polluted and dusty air, I use motorcycle for time saving.
As a female, I feel secure on motorcycle compared to public transport.
In the morning, I go with my husband because our morning schedule is same, but in the evening, I use auto-rickshaw due to different ending timing. Auto-rickshaw is expensive but it is convenient, comfortable, safe, and secure for me.
Sometimes congestion cause problem but less as car users face.
Parking problems of motorcycle are less as compared to car.
Public transport is comfortable than motorcycle.
Careless driving and children crossing cause accidents.
Fluctuation in fuel prices and shortage of fuel is major problem in these days.

7.3.2.3. Public transport and non-motorized modes users

The main reasons of using include low income, do not have private vehicle, and economical compared to auto-rickshaw. One male respondent said, “The bus stop is at some distance from my home and I can walk which is good for health”. Current public transport is expensive due to un-regulation of fare structure and fluctuation in fuel prices reported by one respondent. The respondents told that Qingqi and wagon driver do over speeding for carrying more passengers and bus drivers do not find the way; as a result, thirty minutes travel on bus take one hour. This over speeding behaviour sometime causes accidents. People also feel unsafe in Qingqi, auto-rickshaw and wagon due to presence of gas cylinders. The other factors which most of public transport users consider in travelling are time saving, low travel cost, safety, comfortable, direct route, and vehicle condition, family restrictions in travelling (female), condition of bus driver for safety purpose, un-crowded vehicle, travel distance, and traffic congestion. Almost 50% of public transport users said that social status and personality issues do not matter in their travelling. The religious values do matter in terms of privacy and prayer time. Some respondents told that travelling with other household members have some effect on mode choice, as one said, “*I use auto-rickshaw when I travel with family”*. It looks that most of the public transport users are not satisfied with the service quality of existing public transportation. However, among all public transportation modes, people have good

perceptions regarding service quality and image of Daewoo bus service. Some people prefer auto-rickshaw for long distance travel. The main reasons of not using car are low income and high travel cost, and for not using motorcycle are low income and safety. Some people think that travel cost of motorcycle is higher than public transport. Below are the some remarks of public transport users.

I like to travel by bus because it is safer than Qingqi or motorcycle rickshaw and wagon.
I will use motorcycle if I have because it will save time.
One female said, "I could not travel alone on public transport because of family restrictions".
To me cost does not matter if bus is un-crowded and comfortable.
I will use private car due to safety and less travel time if I have.
Female do not sit at bus stop because they feel uncomfortable due to social and psychological issues.
We do not allow our female to travel alone on public transport due to security and privacy.
It is very difficult to travel for white-collar people on public transport.
Bus is comfortable but frequency is less, wagon is uncomfortable but service is frequent.

7.3.3. Reasons of auto users for not using public transportation

7.3.3.1. Private car and auto-rickshaw users

Car users were requested to tell the reasons of not using public transport in their daily travel or what problems they face if they want to use public transport. From results of interviewees as given in figure 7-3, it looks that car users are not satisfied totally with the service quality of public transportation. The female do not feel secure travelling alone on public transport especially services other than Daewoo bus. These results imply that some major improvements are required in order to attract car users. Most of the car users (11 out of 14) preferred Daewoo bus service if they need to use because they think that it is reliable, secure, comfortable, and safe.

7.3.3.2. Motorcycle and auto-rickshaw users

Results of interviews with motorcycle users as presented in figure 7-3 tell that longer travel time, longer walking and waiting time, high travel cost, bad internal and external environment of vehicle, overcrowding, privacy and insecurity are the main reasons. Some people said that the use of public transport does not match to their class or status. Most of the motorcycle users have preference to Daewoo bus service in case they need to use because it is reliable, comfortable, secure, and safe and even match to the standard of people, but its frequency and routes are less.

7.3.4. Perceptions to desired service quality level of public transportation

Perceptions were asked regarding desired service quality level of public transport from all groups and results are presented in figure 7-3.

7.3.4.1. Private car and auto-rickshaw users

Direct access by public transport, good internal environment, maintained physical condition of vehicle, and protection from outside pollution are the important mentioned

attributes of improved public transport along with reliable and time saving service. Car users have high preferences to sitting, and they said seat quality should be with soft bedding (sofa seat). Maximum walking time to/ from bus stop is 15 minutes; however, it may vary with different weather conditions (hot and cold weather) and user's characteristics. Similarly, maximum waiting time is 15 minutes, even some car users mentioned 2 minutes headway. Most of the car users said that transfer or change of mode should be avoided because transfer increases travel cost and time as well as causes inconvenience in travelling. Out of 14 car users, 9 want roads based public transport service and 5 rails based. The detail of other reported attributes is presented in figure 7-3. Car users have moderate tendency of using improved public transport i.e. 9 out of 14 would use public transport sometimes or occasionally. It means even with improved public transport the car users would make trade-off between car and public transport based on situation and available modes. This is, because in some cases public transport is inconvenient, and not available. Car users may prefer to use their private transport instead of improved public transport in some particular situations such as travelling with family members for shopping and see relatives and in emergency,. However, it can be said that some car users may shift to public transport for their daily travelling if service quality is somewhat to their desired level.

7.3.4.2. Motorcycle and auto-rickshaw users

Among 15 motorcycle users, 11 want roads based and 4 rails based urban public transport service in Lahore. The desired level of service quality attributes of public transport is presented in figure 7-3 and appendix D. Results of motorcycle user's perceptions reveal that the maximum walking time should not be more than 15 minutes and priority must be on lower side i.e. 5-10 minutes. Similarly, most of the motorcycle users have maximum 10 minutes tendency for waiting at bus stop. It means the headway should not be more than 10 minutes. However, a trade-off can be made between demand and frequency of service. The quality of seats should be good i.e. with soft bedding and lining, not plastic or steel. The travel cost of public transport must be lower than current public transport travel cost and motorcycle travel cost. In addition, integration among modes is required in order to reduce the impact of transfer i.e. reduction in travel cost and time and inconvenience. It is highly recommended by motorcycle users that there should be complete physical separation between male and female compartments in vehicle. The outlook of vehicle should be good with pleasant internal environment of vehicle (e.g. proper cleaning and maintenance, air-conditioning, good condition of passengers etc.), and protection from outside pollution. Motorcycle users also have moderate potential of using improved public transport even if service level is made somewhat to their desired level. This may be due to high flexibility and convenience of motorcycle mode because public transport is always not available especially at night, and sometimes it does not provide access to some remote areas. People may prefer to use motorcycle in such cases and travelling with family members and in emergency. Nevertheless, it can be argued that some people have tendency of shifting to improved public transport for their daily travelling.

7.3.4.3. Public transport and non-motorized modes users

According to perceptions of this group as given in figure 7-3 and appendix D, the maximum walking time to/ from bus stop and waiting time at bus stop is 10 minutes. Therefore, it is said that 10 minutes headway is appropriate in peak hour hours and maximum 15 minutes in off peak hours. Seven public transport users want roads and six

rails based public transport service in Lahore. Most of public transport users suggested that travel cost of improved public transport should not be more than current travel cost of public transport. Direct access from origin to destination is better; however, one transfer is fine if it does not cause increase in travel cost and time. Public transport users have high intentions to use improved public transport compared to private vehicle users. It means that the improvement in public transport system would help to keep existing public transport users and restricting them from owning and using private vehicle.

7.3.5. Behavioural intentions of automobile users to fiscal measures

7.3.5.1. Behavioural intentions of car users and auto-rickshaw users

The behavioural intentions of car users were asked to fiscal measures with scenario of improved public transport and these results are presented in figure 7-3. In figure 7-3 the alternatives against each policy are written as totally car (continue to use car same as before), sometimes car (sometimes car and sometimes public transport), and totally public transport (totally shift to improved public transport). In first policy i.e. increase in overall cost; there is significant change in behavioral intentions of car users from 100 to 200% increase. It means the travel cost of car should be more than double of current travel cost in order to shift some car users to improved public transport. In parking charges policy, at 50 PKR all car users selected first alternative i.e. continue to use car same as before, at 75 and 100 PKR almost half car users had dual preference to both car and improved public transport, and at 150 PKR, all car users preferred improved public transport. This implies that the parking charges should be more than 100 PKR for making some promotion from car to improved public transport. In road tax policy, only 10 car users showed full preference to improved public transport at 150 PKR. It means that increase in parking charges with improved public transport has more potential in changing the intentions of car users than increase in road tax. In policy of increase in taxes on gasoline, the preferences towards public transport changed with the increase of tax. It shows that potential exists for increase in taxes on gasoline. These results imply that imposition of such fiscal policies have significant impact on people's preferences towards private car and public transport. However, the extent of impact of each policy on car users will be different depending upon their lifestyles and socio-economic characteristics. During interviews, some car users remarked that increase in annual car registration taxes even up to 200% does not have much impact on their travel behavior because they need to pay once a year, and currently these taxes are not so high. Moreover, government has introduced policy of lifetime registration of vehicle having capacity under 1000 CC; therefore, this policy might not have significant impact on changing behavioural intentions of existing car users, but may have some impact on potential users.

7.3.5.2. Behavioural intentions of motorcycle and auto-rickshaw users

Like car users, motorcycle users were asked for behavioural intentions to fiscal policy measures with scenario of improved public transport and related results are given in figure 7-3. In figure 7-3 the alternatives against each policy are written as totally motorcycle (continue to use motorcycle same as before), sometimes motorcycle (sometimes motorcycle and sometimes public transport), and totally public transport (totally shift to improved public transport). In overall travel cost policy, the intentions to use improved public transport changed with the increase of travel cost. However, even at 300% and 400% increase in travel cost, few motorcycle users still have intentions to use motorcycle. This is due to higher flexibility and convenience of this private mode. This is also, because some motorcycle users belong to high-income group, and they are willing to

pay 300 to 400% increased travel cost of motorcycle usage. However, it can be argued that there would be some change in preferences of motorcycle users towards public transport with the increase in travel cost from 100 to 200%, and this will happen only when travel cost of public transport is much lower than motorcycle travel cost. Even with same travel cost people will prefer to use motorcycle due to its higher flexibility and convenience. When come to parking policy alone, a significant change in intentions can be seen from figure 7-3 at parking charges 30 and 40 PKR. Therefore, it is suggested to increase parking charges from current level (10 PKR) to at least 30 PKR depending area type and land use along with improvement of public transport. Similarly, behavioural intentions changed due to increase in fuel taxes on gasoline. This implies that there is a potential of increase in fuel price with the improvement of public transport. Currently, annual motorcycle registration taxation policy does not exist and people only need to pay when they own a motorcycle. Therefore, people do not believe on imposition of such policy. However, implementation of such policy may tend to increase initial and usage cost which will ultimately influence potential motorcycle owners and users.

7.3.6. Intentions to vehicle ownership of motorcycle and public transport users

7.3.6.1. Intentions of motorcycle and auto-rickshaw users to car ownership

Intentions of motorcycle users were asked to own private car. The main reasons of not owning a car in future are expensive and low income. However, some interviewees have intentions to own a car in future. The main motives of owning include; it is convenient, comfortable, and suitable for family and recreational trip and in emergency. Other factors include personality, give more respect in society, motorcycle is unsafe, protect from air pollution, suitable for long travel and in bad and severe weather. One female said "*I want to buy a car because I can drive and travel independently*" and another one remarked "*currently we do not have parking space at home, and we need to change residence when we will buy a car*".

7.3.6.2. Intentions of public transport and non-motorized modes users to car and motorcycle ownership

Low income is the main reason of not buying motorcycle and car. One public transport users said, "I will buy a motorcycle when I have enough money because public transport is always not available, and it is also suitable in emergency". The main motives of buying motorcycle are convenient, flexibility, cheaper, need of time and can pick up /drop off children at school and easy for family travel. Someone said, "It is very difficult to use public transport every time due to complex schedule of family members (presence of workers and student in family)". It was said by one person that motorcycle is more successful in Lahore than car.

Main factors in buying a car include convenient, flexibility, freedom, comfortable, less travel time, and protection from dust and air pollution. It is suitable for family travel, recreational and shopping purpose. It is also good for health and provides more accessibility. Social status and personality are secondary matters. Car is safer compared to motorcycle and public transport.

7.3.6.3. Intentions to use office based transport service of all modes users

The willingness was asked to use office based transport service from all mode users. Most of them agreed to use with mentioning merits and demerits of this service. The common advantages among all mode users include fix schedule, reliable, safe and secure,

time saving, direct access, convenient, comfortable, cheaper, healthy, punctual, age limit, no operational problem, air-conditioned, no overloading, good condition of vehicle and free from driving. However, some respondents also mentioned about disadvantages in using this service. These include no flexibility in schedule and route (bound to follow), not good in hot weather (may need to walk in some cases from home to stop of service), family members interaction behaviour (drop children at school and other members at office) and may be occupied lengthy route. One motorcycle user said, "It will take more time than motorcycle, and follow length route whereas shortest route by motorcycle, and only cheaper service is always not suitable". Some car users said private car is more suitable because they can drop off/ pick up children at school and do something on the way, and such activities are not possible by travelling with office based transport service.

7.4. SUMMARY OF FINDINGS

This chapter in first part focuses on evaluation of people's preferences to use public transport and private car under situational constraints, mobility restrictions and incentives and moral obligation. It is found that situational constraints have significant influence on people's preferences to use improved public transport. In mobility restrictions on car use, fiscal measures are found to be highly influential in changing intentions along with entry restrictions on car in public transport service area. It is also found that reliability in terms of schedule and travel time, time saving, and higher accessibility are key instrumental attributes in defining the appropriate service quality of public transport. People's moral obligation for preservation of natural resources and reduction of air pollution are helpful in making effective use of improved public transport.

Social/aesthetics and personal orderliness and instrumental attitudinal aspects of private car and public transport are significant determinants of people's preferences to use improved public transport under stated conditions and restrictions. However, different service quality factors of private car and public transport affect the consideration and acceptability of policy measures differently. The respondent's negative attitudes on social/ aesthetic and personal aspects of current public transport tend to decrease the use of public transport under both situational factors and public transport incentives. It is also found that improvements of instrumental aspects of public transport would help in better acceptance of mobility restrictions on car use. It would also help in lifting the moral obligation of people in using public transport. People who have high positive attitudes on social/aesthetic dimensions of private car may reject the mobility restrictions on car use and given incentives of public transport. People have willingness to accept mobility restrictions and public transport incentive even they possess positive attitudes towards functional features of private car. These findings tell that social and personal dimensions of car have more significance than instrumental aspects in determining the mode choice behaviour and people wiliness to accept TDM measures.

Second part of this chapter makes a clear understanding of travel attitudes of different mode users through a qualitative way, and evaluating the relevant strategies required to consider for enhancing the use of public transport. Time saving, flexibility, convenience, freedom, status symbol, and personality are the main motives in the use of car, motorcycle, and auto-rickshaw, whereas low income, safety, and non-vehicle ownership are the main reasons in use of public transport and non-motorized modes. Social, cultural, and religious values, social security of female in travelling, individual's privacy and other related attitudinal aspects are also underlying factors of mode choice behaviour. These aspects need to address importantly in making improvements in public transport system and provision of other travel alternatives to private vehicle. Most of interviewees are not satisfied with the service quality of existing public transport.

However, extended and improved Daewoo bus service has potential in reducing the inefficiency of existing public transport system. The findings of user's intentions to improved public transport and fiscal measures reveal that alone public transport improvements would not be effective in switching the auto users from private vehicle to improved public transport. Public transport improvements need to integrate with fiscal, land use (parking restrictions) and entry restrictions on automobile usage either in isolation or in combination. Results also reveal that office based transport services also have some potential of reducing private vehicle trips even it has some limitations.

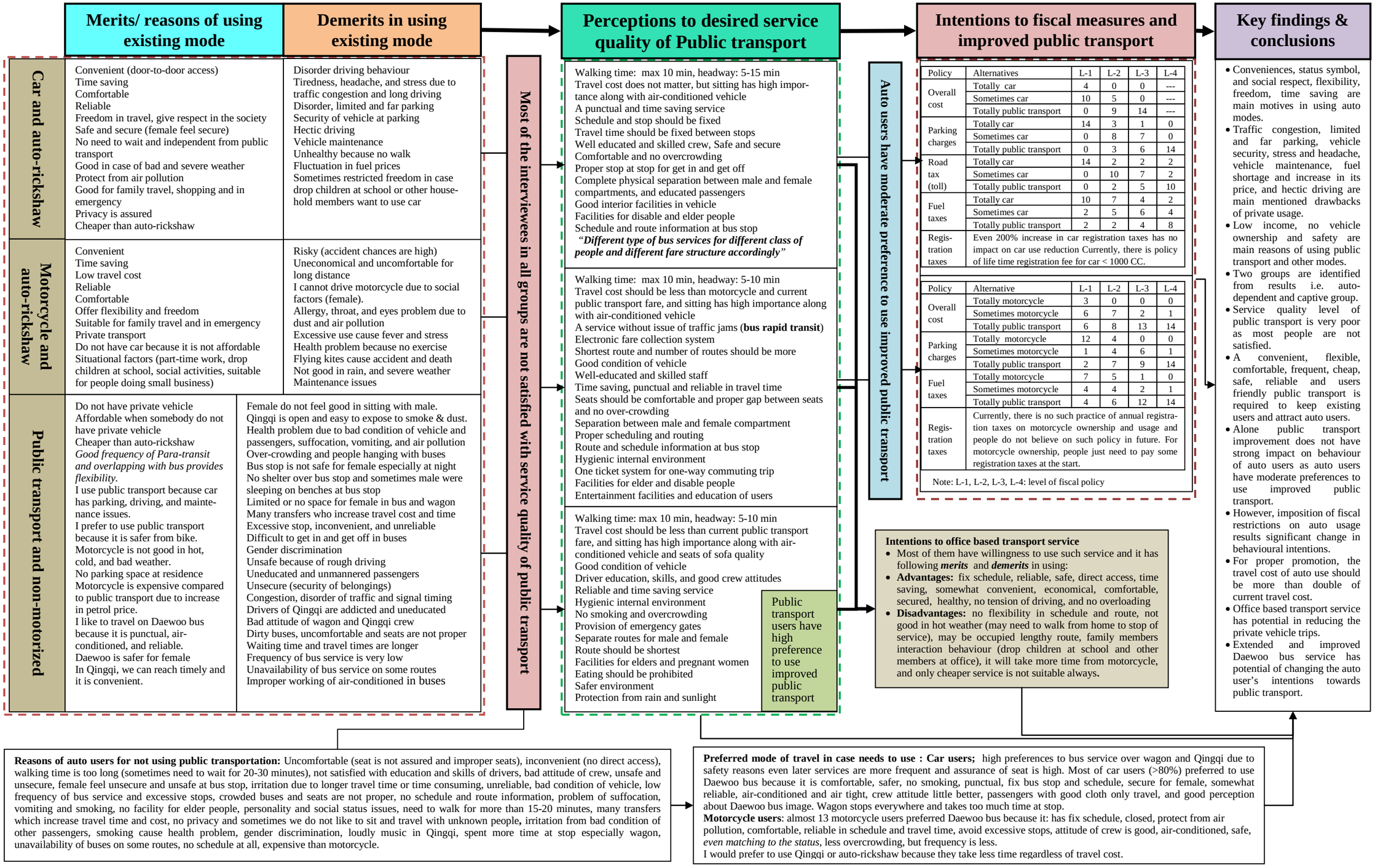


Figure 7-3: A schematic diagram of merits and demerits in travelling, perceptions to public transport service quality, and intentions to public transport improvement and fiscal measures

Chapter 8

DEVELOPMENT OF TDM POLICIES

This chapter develop the policies to draw appropriate TDM measures for effective behavioural change considering the public perceptions and significant influencing factors. Initially, selected measures under each scenario are ranked in terms of public favourability index (PFI) and classified from implementation perspective in terms of short, medium, and long term scenario. Detailed policies have been developed for each TDM measures using background of influencing factors. At the end, a generalized conceptual framework has been proposed that combines the measures and their influencing factors. In this framework, some TDM intervention packages have been suggested for activation of various norms, attitudes, beliefs, and intentions for effective behavioural planning of travellers.

8.1. RATING AND CLASSIFICATION OF TDM MEASURES

Evaluated TDM measurers were ranked using the average response of respondents and results of detailed interviews. 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 from table 5-8, 6-3, and 7-1 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. Similarly, measurers were ranked separately based on detailed interviews results as presented in figure 7-3. Ratings and classifications are given in table 8-1.

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 and soft measures got more favourability from public among all measures. It can be seen from table 8-1 that as coerciveness of measure increases its public favourability decreases. It means public perceive push measures as more aggressive from 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 to improved public transport.

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. These aspects have also been explained in section 8.3. Consideration of different measures in specific period also depends on extent or nature of the objectives to be achieved in certain time relating to change of travel behaviour. 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 8-1 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 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 8-1: Rating and classification of selected TDM measures

<table>
<tr><th colspan="2" rowspan="2">TDM Measures</th><th colspan="4">Public Favourability Index</th><th colspan="3">Period of implementation</th></tr>
<tr><th>LF</th><th>MF</th><th>F</th><th>HF</th><th>Short</th><th>Medium</th><th>Long</th></tr>
<tr><td colspan="2">Advance traffic information</td><td></td><td></td><td></td><td>√</td><td>X</td><td></td><td></td></tr>
<tr><td colspan="2">Traffic education and awareness programs</td><td></td><td></td><td>√</td><td></td><td colspan="3">X</td></tr>
<tr><td rowspan="5">Public transport improvement</td><td>reliable service than car</td><td></td><td></td><td></td><td>√</td><td rowspan="3">Improvements in existing system from operational, capacity & institutional aspects</td><td rowspan="5">Development of rail based transit system</td></tr>
<tr><td>less travel cost from car</td><td></td><td></td><td>√</td><td></td></tr>
<tr><td>less travel time from car</td><td></td><td>√</td><td></td><td></td></tr>
<tr><td>provides direct access</td><td></td><td></td><td></td><td>√</td><td rowspan="2">Development of bus based transport such as bus rapid transit</td></tr>
<tr><td>assured seat with same travel cost & time as car</td><td>√</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Provision of tele-working</td><td></td><td></td><td>√</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td rowspan="2">Intentions to use office transport</td><td>For no reason</td><td></td><td>√</td><td></td><td></td><td rowspan="2">X</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>For reduced cost</td><td></td><td></td><td>√</td><td></td></tr>
<tr><td colspan="2">Increase in parking fee on car use</td><td>√</td><td></td><td></td><td></td><td colspan="3">X</td></tr>
<tr><td colspan="2">Increase in fuel taxes</td><td>√</td><td></td><td></td><td></td><td colspan="3">X</td></tr>
<tr><td colspan="2">Increase in road tax or toll</td><td></td><td>√</td><td></td><td></td><td colspan="3">X</td></tr>
<tr><td colspan="2">Improved public transport + parking restrictions at destination (land use)</td><td></td><td>√</td><td></td><td></td><td></td><td>X</td><td></td></tr>
</table>

TDM Measures		Public Favourability Index				Period of implementation		
		LF	MF	F	HF	Short	Medium	Long
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		
Improved public transport as per demands	Car users		√				X	
	Motorcycle users		√				X	
	Public transport				√	X		
Improved public transport + increase in overall travel cost of car use	@ 100%		√			X		
	@ 200%			√			X	
	@ 300%				√		X	
	@ 400%				√			X
Improved public transport + increase in parking charges on car use	@ 50 PKR	√				X		
	@ 75 PKR		√					
	@ 100 PKR			√			X	
	@ 150 PKR				√		X or > 150 PKR	
Improved public transport + increase in road taxes or toll on car use	@ 50 PKR	√				X		
	@ 75 PKR		√				X	
	@ 100 PKR			√			X	
	@ 150 PKR				√		X or > 150 PKR	
Improved public transport + increase in fuel taxes on gasoline (car users)	@ 20 PKR	√				X		
	@ 30 PKR		√				X	
	@ 40 PKR		√				X	
	@ 50 PKR			√				X
Increase in annual car registration taxes		√ @ 200%				Gradually increase with improvement of public transport		
Improved public transport + increase in overall travel cost of motorcycle use	@ 100%		√			X		
	@ 200%			√			X	
	@ 300%				√		X	
	@ 400%				√			X
Improved public transport + increase in parking charges on motorcycle use	@ 20 PKR	√				X		
	@ 30 PKR		√					
	@ 40 PKR			√			X	
	@ 50 PKR				√		X or > 50 PKR	
Improved public transport + increase in fuel taxes on gasoline (motorcycle users)	@ 20 PKR	√				X		
	@ 30 PKR		√				X	
	@ 40 PKR			√			X	
	@ 50 PKR				√			X
Imposition of or Increase in annual motorcycle registration taxes		√				Gradually impose and increase with transit improvements		

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

8.2. DEVELOPMENT OF POLICIES FOR TDM MEASURES UNDER PUBLIC PERCEPTIONS AND INFLUENCING FACTORS

Policies were developed for selected TDM measures based on results of survey, interviews, and structural equation modelling. As determined in previous chapters, personality traits, travel attitudes, perceived behavioural control in general life attitudes, intentions to reduce car use, perceived freedom and flexibility in travelling, social status and power, selected attitudes towards public transport, social norms in using public transport, perceived behavioural control over public transport, awareness of consequences and sense of responsibility of negative outcomes of car related behaviour, and echo-friendly personal norm are factors influencing the integration of specific TDM measures in Lahore. These factors with their nature of influence (positive or negative) to specific measures are listed in table 8-2.

Table 8-2: Factors influencing the acceptability and effectiveness of TDM measures

TDM measure		**Influencing factors** (nature of influence -- positive or negative)
Advance traffic information, Education and awareness programs, Tele-working, Individual fiscal restriction (parking charges, road toll and fuel taxes)		Personality traits (-) Community and congestion oriented travel attitudes (+) Perceived behavioural control in general life attitudes (-) Intention to reduce use of private vehicle (+) Travel mode(±), and income (±)
Office based transport service for employees or workers, Public transport improvement	Common factors	Situational constraints/ factors (-), Personality traits (-) Community and congestion oriented travel attitudes (+) Perceived behavioural control in general life attitudes (-) Intention to reduce use of private vehicle (+) Attitudes towards public transport (+) Social or subjective norms in using public transport (+) Perceived behavioural control over public transport (-) Perceived freedom and flexibility in travelling (-) Status and auto oriented factors (-) Awareness of consequences of negative outcomes of car use (+) Sense of responsibility of negative consequences (+) Moral obligation for car use reduction or personal norm (+) Travel cost of private car and motorcycle (±) Parking and entry restrictions on car use (+) Income (±), occupation ((±)), and travel mode ((±)
	Specific to public transport improvement	Transit oriented lifestyles and attitudes (+) Auto oriented lifestyles and attitudes (-) Parking restrictions at destination and car entry restriction (+) Personal (-), social (-) and instrumental (-) attitudinal aspects of existing public transport Personal (-), social (-) and instrumental (+) attitudinal aspects of private car
Policy of doubling travel cost of car use by increasing parking charges, fuel and other car related taxes		Attitudes towards public transport (+) Social or subjective norms in using public transport (+) Perceived behavioural control over public transport (+) Perceived freedom and flexibility in travelling (+) Status and auto oriented factors (+) Awareness of consequences of negative outcomes of car use (+) Sense of responsibility of negative consequences (+) Moral obligation for car use reduction or personal norm (+)
Intention to reduce car use, and use alternatives to car (public transport, ride sharing, and office/ campus transport) in response to above policy		Attitudes towards public transport (+) Social or subjective norms in using public transport (+) Perceived behavioural control over public transport (-) Perceived freedom and flexibility in travelling (-) Status and auto oriented factors (-) Awareness of consequences of negative outcomes of car use (+)

TDM measure	**Influencing factors** (nature of influence -- positive or negative)
	Sense of responsibility of negative consequences (+) Moral obligation for car use reduction or personal norm (+) Personal income (-), car users (-), public transport users (+)
Improved public transport + parking charges on car use @ 100 PKR/ Road tax on car use @ 100 PKR / Parking limitations/ Car entry restriction	Personal (-), social (-) and instrumental (-) attitudinal aspects of existing public transport Personal (-), social (-) and instrumental (+) attitudinal aspects of private car
Intentions to reduce use of car/ private vehicle	Situational factors (-), Personality traits (-) Community and congestion oriented travel attitudes (+) Perceived behavioural control in general life attitudes (+) Attitudes towards public transport (+) Social or subjective norms in using public transport (+) Perceived behavioural control over public transport (-) Perceived freedom and flexibility in travelling (-) Status and auto oriented factors (-) Awareness of consequences of negative outcomes of car use (+) Sense of responsibility of negative consequences (+) Moral obligation for car use reduction or personal norm (+) Personal income (-), car users (-), public transport users (+)
Perceived feasibility of environmental protection by reducing car use and buying energy efficient vehicle	Attitudes towards public transport (+) Social or subjective norms in using public transport (+) Perceived behavioural control over public transport (-) Perceived freedom and flexibility in travelling (-) Status and auto oriented factors (-) Awareness of consequences of negative outcomes of car use (+) Awareness of responsibility of negative consequences (+) Moral obligation for car use reduction or personal norm (+)
Moral obligation to reduce use of car or use improved public transport	Personal (-), social (+) and instrumental (+) attitudinal aspects of existing public transport Personal (+), social (-) and instrumental (+) attitudinal aspects of private car

8.2.1. Provision of advance traffic information, and traffic education and awareness programs

These measures got high favour from respondents for implementation in order to reduce traffic congestion and related problems. Positive association of travel attitudes and intention with these measures implies that provision of advance traffic information and education programs will help in changing the attitudes and intentions of people for change of travel behaviour. More people aware about problems and their alternative solutions through information and education sources more likely they will shift towards sustainable travel behaviour. Conventional and simple type traffic information sources such as traffic radio are very useful in short term to address congestion-oriented problems in developing countries. However, state-of-the-art advance traffic information systems need to incorporate along with conventional sources to make individual trip planning and transportation system more effective. Traffic information media should be capable to observe actual traffic conditions on congested and unreliable routes. Disorder driving behaviour results un-expected events on roads in terms of traffic congestion and accidents, and low education results misuse of transportation facilities or uneducated people do not know how to drive a vehicle properly and how to use transportation facilities. Therefore, traffic education and awareness programs need to initiate on priority basis as traveller's education and awareness is the key in minimizing the traffic problems. These programs should be initiated both at the basic level (i.e. inclusion of traffic education in curriculum at school level) and before issuing of driving license. Such

programs should educate and motivate the people regarding the use of sustainable travel alternatives.

8.2.2. Tele-work

There is potential for promotion of tele-work policy in Lahore for specific segment of travel market. It can be helpful in reducing the use of private vehicle, because one main reason of using private vehicle is the part-time work or side business. If skilled and educated people can get such part time opportunity through online working programs then it would help in reducing the use of private vehicle. The potential to utilize tele-working opportunities is more among those people who care about traffic congestion and air pollution and have positive interaction with community in travelling. Gender, income, and mode dependency also contribute in determining its potential and it may be helpful for skilled females who cannot work due to social and family issues. Middle-income people with higher education should be the target group of this policy because trend of doing part-time work is more in middle-income group. Therefore, government should create opportunities by making essential for the organizations to keep some quota for such activities, and make public aware about these working opportunities through marketing and awareness programs.

8.2.3. Office based transport service for employees

Office based transport service has potential of reducing the private vehicle dependency although it has some limitations. This potential is also supported by results of modal share of this study i.e. almost 5-6% respondents use office/campus transport. However, people who do part time job and business and travel with family members have less tendency of switching to this service, because they think that it will limit their flexibility and freedom in travelling. The female have more potential to use this service because they feel safer and secure on it compared to public transport. Public transport, community, and congestion oriented travel attitudes and eco-friendly personal norm of people have positive impact on use of office-based transport. It means activation and promotion of such attitudes and norms of people through awareness and motivation programs would help in enhancing the use of such service. Potential to use service decreases with the increase of income; however, civil employees have more tendency of using. It implies that first government should initiate this service in all public sector organizations, and then make it compulsory for private sector to follow this policy.

8.2.4. Public transport improvements

Improvements in public transport will help in making shift from private vehicle to public transport. Public transport should be capable to keep existing users and attract potential users such as motorcycle and car users. Specifically, with some necessary improvements, Daewoo bus service has potential to overcome the some deficiency of existing public transportation system in Lahore because people's have good perceptions regarding image of this service. These improvements include increase in spatial and temporal coverage (frequency and routes), improvements of bus stop conditions with ensuring proper safety and security of passengers, and low travel cost. Symbolic and functional characteristics of public transportation modes need to improve along with affordable travel cost and less in-vehicle and out-of-vehicle travel time. In other words, specified social/ aesthetic and personal dimensions of public transportation modes should have equal importance in improvements along with instrumental incentives as these aspects play major role in mode choice behaviour.

People's positive attitudes on social status and power, and auto-oriented factors such as flexibility and freedom in travelling tend to decrease the use of public transport. Eco-friendly personal norm, social norms, and attitudes towards public transport have positive influence on people's potential to use improved public transport. Similarly, congestion and community related attitudes result positive influence on use of improved public transport. Different modes users belong to different social and economic groups and heterogeneity exists between them for lifestyles and attitudes; therefore, to keep existing users and attract auto users the service quality should be according to their demands and satisfaction. Cheaper service may be enough to keep existing users such as low-income people but not sufficient to attract auto users. As its usage tends to reduce the flexibility and freedom in travelling; therefore, some other service improvements are required.

It is very difficult to provide a public transport with service quality level equal to private car or motorcycle such as door-to-door and 24 hour service. However, some service attributes can be made competent enough or even better to private transport such as reliable (punctual and scheduled service, introducing bus lanes or congestion free service) and frequent service, ensuring proper safety with educated and skilled crew and better vehicle condition, comfortable service (better seat quality, air-conditioned, no overcrowding), and hygienic internal environment of vehicle with protection from outside pollution (dust, air and noise pollution). Similarly, integration among public transport modes in-terms of transfer/connecting point, travel cost and time is required. The connecting or transfer point should be at proper place and easily accessible. This would help in reducing the inconvenience in using public transport because transfer always causes inconvenience to users, and increase in travel cost and time. Para-transit modes should be designed as a feeder service to major transit lines such as BRT and rail transit. From perceptions to desired service quality of public transport, it can be said that a maximum 10 minutes ingress/egress time is appropriate for planning and designing routes of public transport modes; however, preference should be on lower side considering the severity of weather, local and social conditions. It is argued that headway in peak hours should be less than 10 minutes and in off peak hours 15 minutes. To keep existing users and attract potential users the travel cost of public transport should be less than current travel cost of public transport and motorcycle. It is difficult to provide a service with 100% sitting due to financial and operational issues. However, ensuring comfortable standing and avoiding overcrowding can help to keep existing users, and attract auto users. Another way to address this issue is the provision of differential type service i.e. service with different sitting capacity and fare structure for different type of users. Seats should be with soft bedding (not plastic or steel), and sufficient gap between them for comfortable sitting. Complete separation between male and female compartments and bus stop with lighting and sitting facilities are required to address the issues of privacy, and security in using public transport. Other mentioned important features of good quality public transport are proper scheduling and routing (route should be shortest), dissemination of schedule and route information at main terminal and bus stops, prohibition of smoking and eating in vehicle, electronic fare collection system, facilities for elder and pregnant women, and provision of emergency gates. One reason of auto users of not using public transport is the physical condition of passengers and behaviour of crew. Therefore, education and awareness of public transport users for how to use it is also much important for better internal environment of vehicle, and attraction of status and personality conscious and high-income people. Auto users have low preferences to use improved public transport even if service quality level is made according to their demands. However, the preferences of auto users can be changed effectively by imposing

fiscal restrictions on car and motorcycle usage. Similarly, limiting the parking facilities and car entry in public transport service area can help in changing the people's intentions to use public transport. In addition, image of public transport need to improve and maintain from perspective of existing and auto users, because people adapt after what they perceive about a service. Therefore, perceptions of auto users need to change regarding the image of public transport after making improvements. This can be done through social marketing and awareness campaigns or using soft policy measures.

8.2.5. Fiscal measures

The travel cost of car and motorcycle should be more than double of current travel cost in order to shift some car and motorcycle users to improved public transport and other travel alternatives,. It can be done by increasing the taxes on fuel and annual vehicle registration taxes, and imposing/increasing road taxes and parking charges on use of private vehicle. People's perceived behavioural control over public transport has negative impact on behavioural intentions to fiscal measures, and implies that perceived difficulty and restricted freedom in travelling using public transport is a major hindrance in reduction of car use or people's intentions to use alternative travel options. Instrumental factors such as status, social power, and personality tend to reduce the acceptability of fiscal measures. People who have more concern about traffic congestion and air pollution, and possess community oriented attitudes have more potential of accepting alternatives in response to 100% increase in travel cost of car use. Moreover, activation or regulation of people community oriented attitudes and positive attitudes towards public transport, social and echo-friendly norms is essential in reducing the car use or private vehicle and acceptance of fiscal measures. Motorcycle and public transport users will not buy and use a car unless or until they can afford to do it. Similarly, public transport and non-motorized modes users or low income people will not buy and use a motorcycle unless or until they can afford to do it. It means that the earlier imposition of fiscal restrictions would help in restricting these groups from owning and using private vehicle. However, other competent travel alternatives need to provide for better acceptance and effectiveness of fiscal measures. These alternatives include improved public transport, transport service for employees, school/campus transport, and promotions of ride sharing programs. Moreover, acceptance of fiscal measures depends on public awareness about the benefits associated with the implementation of each measure. Public awareness about available alternatives to private vehicle is also important for better acceptance of fiscal measures.

8.2.6. Parking and car entry restrictions in public transport service area

It is found that limiting the parking facilities at destination has tendency to enhance the use of improved public transport. Proper land use policies are required related to provision of parking facilities at different locations. Providing a good quality public transport in highly congested areas e.g. city centre or central business district (CBD) with parking restrictions and car entry restrictions can approve a powerful tools in either reducing the use of private transport or enhancing the use of improved public transport. Talking about car entry restrictions in detail, entry can be restricted either fully or partially depending on nature of land use and transportation problems to be handled and level of public transport service. In partial entry approach, entry can be made based on even and odd registration number (last digit) of vehicle for alternative weekdays or restricting entry for specific period of the day. Similarly, in commercial and business areas served by good quality public transport the supply of parking facilities can be

controlled in order to enhance the use of public transport. However, strong enforcement of policies is required in this regard.

8.2.7. Intentions and moral obligation for reduction of car use, and perceived feasibility of environmental protection

For better acceptance of TDM measures, first people should have personal intention and moral obligation 'of not using or reduce usage' of private vehicle for reduction of traffic congestion and environmental problems. Community and congestion oriented attitudes and better control over behaviour can help people in reducing the car use. However, people high attitudes on personality and status traits tend to increase the usage of car or other auto transports. People's awareness and social responsibilities have high significance in reducing the car use. Similarly, people's high moral obligation for preservation of natural resources and reduction of air pollution are helpful in making the effective use of public transport and other travel alternatives to private vehicle. It is needed to make people aware regarding the negative outcomes of their behaviour, and activate their social and personal norms in order to change travel attitudes and behavioural intentions as well as willingness to buy energy efficient vehicle. Moreover, social support and motivation is also much important for promotion of sustainable travel behaviour.

8.3. DEVELOPMENT OF CONCEPTUAL FRAMEWORK OF TDM POLICES

A generalized conceptual framework of TDM strategies and their influencing factors is proposed as shown in figure 8-1. It would help in drawing the appropriate measures based on individual's lifestyles, socio-economic features, beliefs, attitudes, norms, and intentions in order to assure mobility of people, and mitigate traffic congestion and related environmental and social problems. Some intervention packages were designed using different TDM measures in order to motivate the people for the use of improved public transport and other travel alternatives to private transport. This study divides the proposed interventions or TDM measures into three packages that require for activation and self-regulation of different norms, attitudes, control beliefs, and personal intentions. These packages follow the concept of equation 8.1 as proposed in this study and proposed generalized framework of self-regulation and interventions techniques of Bamberg *et al.* 2011. Equation 8.1 tells that public favourability for particular TDM measurer(s) can be improved by maximizing the influence of factors have or tend to have positive effect and minimizing the influence of factors have or tend to have negative effect on acceptance and effectiveness of measure(s) through proper design of intervention packages of TDM measures. This study simplifies the previous framework of Bamberg *et al.* 2011 into three major packages that need to deem in developing countries for effective behavioural change i.e. (1) education and marketing of travellers, (2) supporting transport policy for behavioural change, and (3) enforcement policy. In other words, it follows the 3E's principle i.e. **E**ngineering, **E**ducation, and **E**nforcement. It means, do ***engineering*** works to provide supporting transport infrastructure for change of behaviour, ***educate*** the public for change of travel behaviour in perspective to use sustainable travel alternatives, and at the end, ***enforcement*** of policies by making and implementing supporting laws. Usually the most effective way of influencing travel behaviour is a combination of two or three E's. First package of education and marketing includes mainly soft TDM or mobility management measures i.e. education and awareness programs, social marketing and motivation programs, and awareness through traffic information media. In second package, it is proposed to design supportive transport

policy for effective behavioural change. This supportive policy includes public transport improvements and development, provision of other alternatives to private vehicle (i.e. office and campus transport, pooling services, ride-sharing programs), provision of advance traffic information, incentives on reducing or efficient use of private vehicle, and disincentives on use of private vehicle. These disincentive measures include provision of parking restrictions, increase in vehicle registration taxes, and other taxes related to private vehicle usage and car entry restrictions in transit oriented areas. Last package of interventions insist on making laws and their enforcement because these legal restrictions can be helpful in making other interventions effective in changing travel behaviour. Therefore, provision of legal restrictions is necessary along with education and marketing programs and supportive transport policy. All these packages individually and/or collectively would help in changing attitudes, norms, control beliefs, and intentions of people, creating awareness among people about merits and demerits of all transport alternatives, and increasing the advantages in using public vehicle and other environmental friendly alternatives, and reducing the advantages of using private transport. In other words, they would help in promoting the sustainable travel alternatives. Interdependency exists between different types of measures i.e. acceptance and effectiveness of pull measures is dependent on acceptance and effectiveness of psychological measures, and acceptance and effectiveness of push measures is significantly affected by effectiveness of pull and soft measures. In general, it is argued that the effectiveness of supporting transport policy package depends on integration of other two packages. However, supporting transport policy package is further divided into two packages, and they are connected with double headed arrow in figure 8-1. These packages are termed as incentive package and disincentive package, and double headed arrow indicates that the acceptance and effectiveness of these packages are interrelated with each other. It means the incentive or pull measures should be integrated with disincentive or push measures; however, push measures cannot be implemented before the pull measures. Finally, framework points out the change in travel behaviour and pattern as result of effectiveness of TDM measures. Consequently, efficiency of existing transportation system, urban environment, and quality of life would be improved.

$$Public\ \ favorability\ \ for\ a\ measure = \frac{\begin{array}{l}Maximize\ the\ influence\ of\ \ positively\\ affected\ \ factors\ through\ TDM\ \ interventions\end{array}}{\begin{array}{l}Minimize\ the\ influence\ of\ \ negatively\\ affected\ \ factors\ through\ TDM\ \ interventions\end{array}} \quad (8.1)$$

8.4. SUMMARY

Studied TDM measures were ranked in this chapter for public favourability index, and classified for period of implementation. Soft and pull measures got higher favour from public, whereas push measures low favour. However, public favourability for specific measure changes with the change of presented scenario or coerciveness or measure. Policies were developed based on findings of previous four chapters for each measure and a generalized framework proposed for self regulation as modification of Bamberg *et al.* (2011) framework.

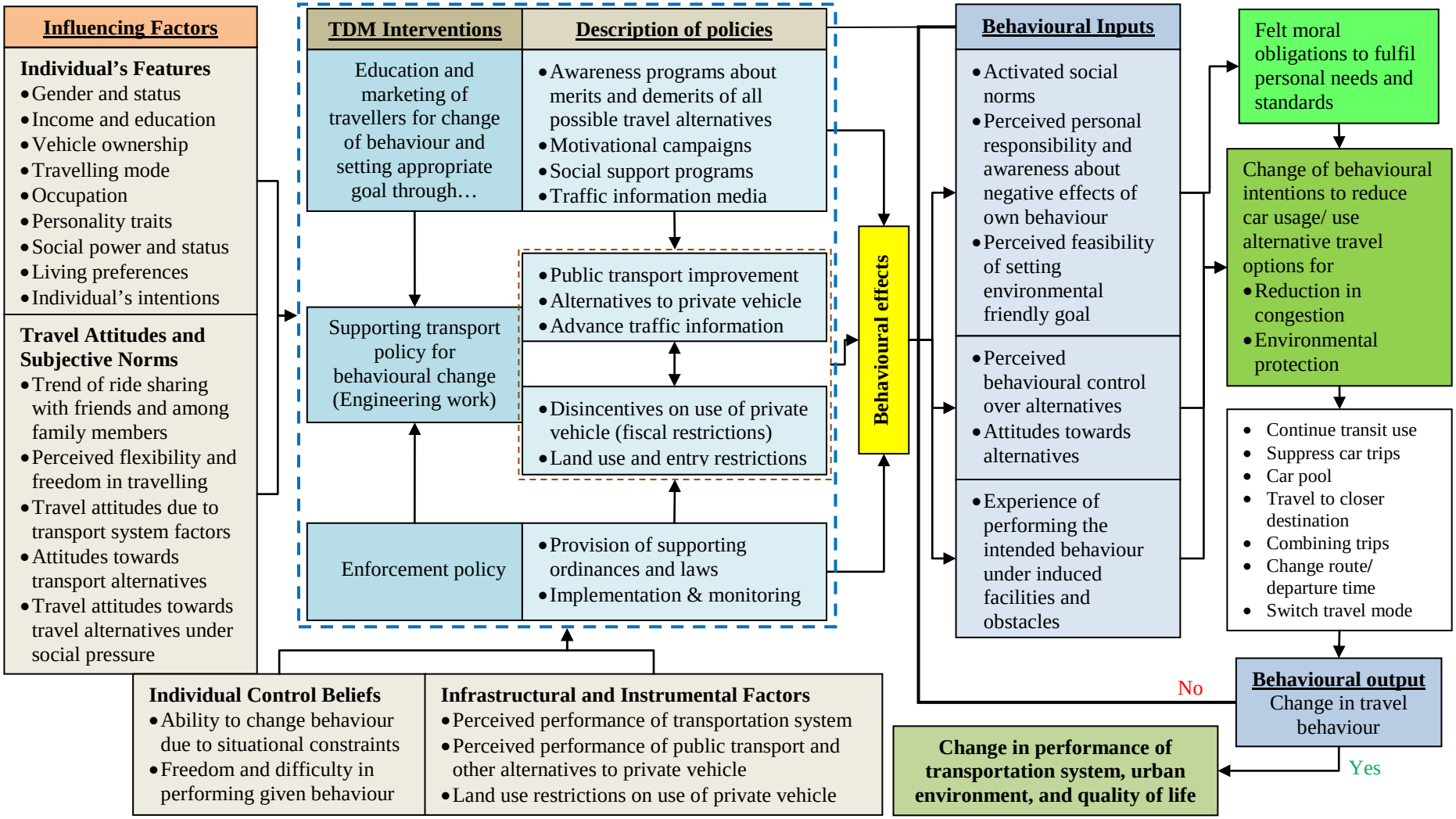


Figure 8-1: A generalized framework of influencing factors, intervention/TDM packages, and self-regulation stages

Chapter 9

CONCLUSIONS AND RECOMMENDATIONS

This chapter concludes this research, and suggests the implications of findings for Lahore city as well as cities of other developing countries. At the end, recommendations have been made for further research relevant to the scope of this study.

9.1. SUMMARY OF FINDINGS

This section summarizes the main findings of this study.

Radio traffic information has significant influence on road user's trip planning during congestion and unexpected events. The future preferences of travellers with traffic radio are highly dependent on their current listening propensity and satisfaction with the service quality of traffic radio. Broadcasting frequency, accessibility, geographical coverage, and reliability of information are key features of service quality of traffic radio.

Flexibility, freedom, convenience, reliability, status symbol, personality, and time saving are major motives in the use of private vehicle, whereas low income, non-auto ownership, and safety are main reasons of people for using public transport and non-motorized modes. Social, religious, and family values, and weather and environmental factors also contribute appreciably in mode choice behaviour, and their importance varies across different mode users or people belonging to different socio-economic groups. Two pattern of travel behaviour exists in Lahore i.e. auto-dependent behaviour of people who have private vehicle, and captive behaviour of people who do not have private vehicle. Currently, service quality of existing public transportation is very poor and major improvements are required. Symbolic, functional, and cost and time factors of service quality are significant determinants of commuter's satisfaction with public transportation. Daewoo bus service has potential of keeping existing users and attracting auto users with some improvements, because it is attractive, reliable, comfortable, secure, safe, and people have good perceptions about its image.

Auto-oriented and transit oriented lifestyles and attitudes have different impact on commuter's preference to use public transportation. Heterogeneity exists among different modes users for lifestyles, attitudes, intentions, and attitudes towards TDM measures. Personality traits, community and congestion oriented travel attitudes, situational factors or constraints, perceived freedom and flexibility in travelling, social power and status, attitudes towards public transport, social or subjective norms, perceived behavioural control over public transport, awareness and responsibility of negative outcomes of car related behaviour, and echo-friendly personal norm are significant determinants of people's behavioural intentions (reduce usage of private vehicle or preferences to use alternative travel options to private vehicle) and attitudes towards specific TDM measures. Personal and social norms and perceived freedom and flexibility in travelling have significant effect on people's intentions to protect environment from negative impact of car use, and willingness to buy energy efficient vehicle. High income and status conscious people as well as who have high belief on freedom and flexibility of auto transport may reject the alternatives to car, and accept the policy of doubling travel cost of car use. However, this policy would help in restricting the potential car owners and users from owning and using the car.

Social/aesthetics and personal orderliness, and instrumental attitudinal aspects of private car and public transport are significant determinants of people's intentions to use improved public transport or reduce use of private car. However, different service quality factors of both modes affect the consideration and acceptability of policy measures differently. Social and personal dimensions have more significance in determining the mode choice behaviour. Acceptance and effectiveness of improved public transport depends on competitiveness of public transport service quality to private transport, and integration of mobility restrictions on use of private vehicle.

People perceive soft and pull measures are highly favourable, and push measures least favourable. The selected pull measures i.e. tele-work, office based transport service and public transport improvement measures have potential of implementation and reduction of private vehicle trips as public acceptability is high for these measures. Interdependencies exist between soft, pull and push measures, and acceptance and effectiveness of one-category measures may affect these aspects of other categories or acceptance and effectiveness of different measures are interrelated. Proposed interventions framework of TDM measures as well as ranking and classification schemes are vital in designing appropriate sets of TDM measures to achieve appropriate standard of urban mobility and for effective behavioural change.

Questionnaire survey can be designed and conducted in developing countries considering traveller's lifestyles, attitudes, intentions, and norms. Moreover, the TPB and NAM in isolation as well as in combination can be used as frame of reference for design of questionnaires in grasping public perceptions for evaluation of travel behaviour and attitudes towards TDM measures. However, proper attention should be given to selection of target group of travel market and survey methods, selection of questionnaire items and their wording, and ordinal scales, selecting and presenting policy scenarios to the respondents, placement of specific questions and different parts of questionnaire.

9.2. IMPLICATIONS OF TDM POLICIES

This study argues that TDM strategies need to plan and implement seeking the lifestyle pattern, attitudes, intentions, and norms of target group of travel market. It would help in achieving the objectives effectively of a specific policy measure. Proper attentions should be given to infrastructural, instrumental, symbolic, social, personal, and psychological factors while designing appropriate sets of policy measures for a city.

9.2.1. Implications for Lahore

This section initially presents the implications of each measure separately, and then, ends with combined discussion on implications of all measures.

It is suggested that real-time information should be designed to support both pre-trip and en-route decisions, and recurring and non-recurring congestion events. Advance traffic information sources can be used to influence the travel behaviour through effective individual trip planning. The service quality of traffic information media should be good enough to make a significant impact on traveller's behaviour. Education and awareness of travellers is vital in reducing the traffic congestion, and traffic information sources such as traffic radio can be used to educate the people about traffic rules as well as traffic problems and their solutions. Traffic education and awareness programs need to initiate in conjunction with strict implementation of land use policies and traffic rules. Moreover, benefits associated with the use of public transport and other alternative to private transport need to highlight to the public through these psychological or soft measures. It

would help in developing appropriate attitudes, beliefs, norms, and intentions that can be handy in promoting environmental friendly behaviour.

People who have more concern about traffic congestion, community and environmental problems would strongly support the tele-working policy. Provision of tele-work opportunities can help in reducing the private vehicle trips, because people who do part-time work can avail such opportunities and may become little independent from private vehicle. They can do part-time work at home and submit online or travelling once a week. Elimination of this trip (trip related to part time work) can switch workers to improved public transport. In addition, this strategy would help in creating working opportunities for skilled women who generally do not work due to family and social issues. Moreover, public awareness about such opportunities is important for effective utilization and this can be done through social marketing and awareness programs.

Office based transport service has potential to reduce private vehicle trips. It is suggested that government should make some ordinance regarding the provision of such transport, and make compulsory for all organizations and institutions to provide transport service for their employees. People who have environmental friendly and transit oriented attitudes and norms would prefer to use this service. Promotion of such attitudes and norms through awareness and marketing programs would help in enhancing potential of this service. Provision of this service at least can attract some private vehicle users such as middle income group because it is cheaper, reliable, safe, and secure. It is suggested to impose parking restrictions on private vehicle usage along with provision of this service because free parking or low parking fee tend to encourage the use of private vehicle. Moreover, implementation of tele-working policy in conjunction with office based transport service can contribute to success of each other.

Improvements in public transport would help in making shift from private vehicle to public transport. Therefore, provision of an efficient, affordable, economical, safer, users and environmental friendly public transportation should be prime responsibility of authorities. Target groups of public transport policy in short and medium term should be current public transport users, and potential users i.e. middle income group or motorcycle users. In the long term, car users should be the target group of public transport improvements and development. Improvements in public transport would help in keeping existing users and attracting private vehicle users. With some necessary improvements (e.g. spatial and temporal improvements), Daewoo bus service has potential to overcome the deficiency of existing public transportation in Lahore because people's have good perceptions about the image of this service. Improvements in public transportation need to make deeming the desired service quality level of all segments of travel market. Service quality of improved public transport should be competent enough to auto transport that white collar or status and personality conscious people do not mind in using it. Social and personal dimensions of public transport should have equal importance along with instrumental attributes in improvements. Communicative and social marketing programs should be used in order to improve the image of public transport to the existing and auto users. Such programs would be helpful in developing and regulating positive attitudes and norms towards image of public transport. Furthermore, in order to improve transit facilities in real sense the government should encourage, and facilitate local authorities to introduce competitive mass transit system based on people's lifestyles, attitudes, and preferences. For this, long term strategic intervention is required to meet public transport demand such as provision of equitable road space for public transport, performance-based incentives to the operators and reforms for bus and Para-transit operations. Para-transit services need to restrict as feeder service to developed bus and rail rapid transit lines.

Moreover, to accommodate people of different economic and status groups, public transport with different service level can be provided.

Alone public transport improvements and provision of other travel alternatives to private vehicle will not be appropriate in changing the people's intentions as these alternatives tend to reduce the freedom and flexibility in travelling. Imposition of fiscal measures and other mobility restrictions on use of private vehicle is essential such as parking and entry restrictions. Improvements in public transport and other alternatives on one side would help in reducing the inconvenience and difficulty in using them, and on the other hand, imposition of fiscal and mobility restrictions on use of private vehicle would help in limiting its freedom, flexibility, and convenience. Making auto free zones or car entry restrictions in public transport service area after developing state-of-the-art public transport can be powerful policy in making modal shift in highly congested areas. Considering auto-rickshaw entry restrictions in specific areas for environmental reasons it can be argued that this strategy can be implemented if government has will to do otherwise not. Similarly, limiting the parking facilities and imposition of high parking charges in transit-oriented areas can help in improving the use of improved public transport. However, land use policies need to revise and implement in relation to above measures.

People especially high-income or status conscious and auto-oriented groups have willingness to pay road taxes in order to use uncongested roads, and support to increase taxes on fuel for reduction of air pollution. A simple type urban road toll or pricing schemes (e.g. road based toll) can be imposed that should be easily acceptable and understandable both for public and authorities. Collected revenues from such groups through taxes and charges can be used to improve transportation infrastructure especially public transport. Respondents showed low willingness to increase carbon tax on gasoline and parking charges at work sites due to social impacts. A differential type fuel pricing structure (fuel pricing based on vehicle type) is suggested considering the social impacts of increase in taxes and environmental problems, and price can be increased gradually up to 40-50 PKR. Imposition of parking charges has more influence in changing car user's preferences than other fiscal measures. Therefore, it is suggested to impose and increase parking charges gradually both at commercial and business areas. It is also suggested that parking charges and road taxes on car use should be more than 100 PKR with the scenario of public transport improvement and provision of other travel alternatives. Similarly, it is suggested to increase parking charges on use of motorcycle up to 30 PKR. In addition, imposition of or increase in annual registration taxes on vehicle ownership (both car and motorcycle) need to consider for effective control of ownership and usage.

Acceptance of fiscal measures will be high if people well know about the right utilization of collected taxes. Therefore, public awareness is much important about the benefits associated with the implementation of fiscal measures. Social marketing and public awareness programs such as radio, TV, seminars, and workshops need to use before implementation in order to highlight the benefits to the public. For example, acceptance of fiscal measures will be high if people well know about the right allocation of collected taxes i.e. collected revenues will be used for public transport improvement and reduction in car use would help to reduce traffic congestion and air pollution. In return, it would reduce travel time and cost as well as health cost. Imposition of fiscal measures would help in restricting the public transport and non-motorized modes users from owning and using private car and motorcycle, and motorcycle users from owning and using private car. These measures will also help in promoting the ride sharing trend among users of private vehicle by sharing increased travel cost with colleagues/friends.

Proposed ranking and classification schemes and intervention packages need to deem for designing appropriate sets of policy measures. Incentive or pull and soft measures need to initiate first which should be followed by push or disincentives measures. It is suggested that integration between measures is important because any measure alone cannot be effective in changing the travel behaviour. In other words, policies should be adopted either sequentially or somehow simultaneously depending upon nature of policy and objectives to be obtained. Table 9-1 presents the proposed TDM measures for different periods and groups.

Table 9-1: Proposed TDM measures for different terms and users

<table>
<tr><th colspan="2">Term</th><th>Group</th><th>Green travellers (transit and non-motorized modes users)</th><th>Motorcycle and car users</th><th>All groups</th></tr>
<tr><td colspan="2" rowspan="2">Short</td><td></td><td>• Improvements in existing public transport (temporal, spatial, social, personal and functional aspects, and travel cost < current travel cost)
• Public transport schedule and route information</td><td>• Promotion of ride sharing trend among private vehicle users including auto-rickshaw/taxi users
• Provision of tele-working opportunities</td><td rowspan="3">Induction of social support and motivation, and marketing programs for promotion of improved public transport, and other provided travel alternatives to private vehicle by highlighting their merits and demerits to the public</td></tr>
<tr><td colspan="3">• Traffic education and awareness programs
• Work place travel plans (office based transport service)
• Study place travel plans (provision of transport service for education institutions at school, college and university level)
• Improvements in existing traffic radio service, and provision of other advance traffic information sources for better route, departure time and mode choice
• Increase in travel cost of private vehicle i.e. travel cost of private vehicle ≥ 2 times of current cost as per classification in previous chapter</td></tr>
<tr><td colspan="2">Medium</td><td colspan="3">• Traffic education and awareness programs
• Development of bus rapid transit (BRT)
• Limited parking facilities for private vehicles in transit supported areas
• Auto free zones with state-of-the-art public transport facilities (BRT)
• Increase in travel cost of private vehicle i.e. travel cost of private vehicle ≥ 3 times of current cost as per classification in previous chapter</td></tr>
<tr><td colspan="2">Long</td><td colspan="3">• Traffic education and awareness programs
• Development of rail based transit system
• Limited parking facilities for private vehicles in transit supported areas
• Auto free zones with state-of-the-art public transport facilities (Rail mass transit)
• Increase in travel cost of private vehicle if needed as per classification in previous chapter</td></tr>
</table>

9.2.2. Implications for developing countries

Some implications for cities of developing countries are suggested despite differences in local circumstances among countries. The focus point of study about uniqueness and generalization of findings is simply that planners and policymakers need

to be sensitive to local factors when thinking about implementation of various policies. However, main implications regarding cities of developing countries include:

- ♣ Generally, this study would provide deep understanding of significant factors that need to consider in implementing various TDM measures for change of travel behaviour. It would also be helpful in designing appropriate sets of policy measures.
- ♣ Traveller's readability and affordability matters need to focus in deciding the nature of traffic information source. It is suggested that audio type traffic information would be more viable option than text or video media because road users can easily access and understand such information. Provision of such simple and conventional type traffic information sources can be handy to educate people, and alleviate traffic congestion up to some extent.
- ♣ Provision of tele-work and office based transport policies depends on policies of local governments regarding organizations and institutions, intentions of organizations and institutions itself, and willingness to accept of local people.
- ♣ The target groups of public transport development and improvements policy in short to medium term should be current public transport users, and people who have more potential of using in future such as motorcycle users. The service quality of public transport must be competent enough to private transport in all aspects, and it should be apposite and affordable for customers belonging to different social and economic groups of a city.
- ♣ Implications of fiscal measures vary from country to country, because it depends on structure of taxation on ownership and usage of private vehicle in each country as well as the rate of automobile ownership. In some cases, government provides supportive policies for automobile ownership and keeps the taxes on lower side, and in some cases, it may be opposite. In addition, in some countries, government policies are not supportive for transit developments that generate more demand for automobile ownership and usage. Therefore, it is suggested to adapt fiscal measures considering the local taxation structure for vehicle ownership and usage and condition of public transportation. However, imposition of such vehicle related taxes would help in generating revenues that can be used for the improvement of transit system and other infrastructure even if it would not have significant impact on reduction of automobile usage.
- ♣ Measures should not consider in isolation, combinations or packages of measures are more appropriate for effective change of travel behaviour.
- ♣ The proposed joint-model of TPB and NAM with additional variables can be applied in assessing the behavioural intentions to TDM measures. However, application may vary across different segments of travel market because this study included perceptions of only specific group of people.
- ♣ Segmentation of travel market is much important to make effective implementation of specific measures because some measures are suitable only for specific segment. For example, tele-work strategy may be only suitable for highly educated commuters not for all. Similarly, car or vanpooling and ride sharing programs require special attentions in implementation due to religious and social factors.

9.3. RECOMMENDATIONS FOR FUTURE RESEARCH

It is difficult to study all aspects or to answer all the problems or questions relevant to a particular research topic in one study. More researches are required to answer the questions or problems related to academic and practical field. Following are the some

recommendations for further research related to issues of travel behaviour and implications of TDM measurers in Lahore and cities of other developing countries:

- Public attitudes towards TDM measures are also affected by interaction between measures. In other words, combined TDM measures have more influence on expected car use reduction compared to individual measures such as combination of public transport improvements with parking control measures. Therefore, it is recommended to evaluate public attitudes for packages or combination of TDM measures. It can be investigated with a 'stated preference' experimental design of alternative travel demand management packages using conjoint analysis approach.
- It looks that travel behaviour of motorcycle users is more critical than car users because they are potential users of car and can be potential target group of improved public transport for modal shift. In other words, it plays a role of transition mode between private car and public transport. It may be difficult to switch car users to public transport as they belong to high-income group and they are more conscious in terms of personality, privacy, and status symbol. In addition, motorcycle users mainly belong to middle income and young age groups, and motorcycle also accounts major share in modal share as well as of traffic on road network. Therefore, detailed evaluation is needed of travel behaviour and attitudes of current and potential motorcycle users towards TDM measures. It can help in switching the motorcycle users to public transportation and reducing the rate of accidents and fatalities in Lahore as motorcycle is least safe transport mode.
- It is recommended to evaluate the feasibility of providing differential type public transport service in order to accommodate people belonging to different socio-economic groups, and attitudes towards public transport as the BRT operation has started on one route since February 2013.
- This study also suggests the validation of proposed joint model of TPB and NAM with three additional variables considering variety of travel market in sample e.g. workers, low income, and less educated people as sample in this study included specific segments of travel market i.e. middle and high income people.
- Political, institutional, and technical aspects of studied TDM measure also need to assess before making decision regarding implementation.
- The benefits (social, economic, and environmental benefits) associated with the implementation of a specific measure need to mention in a questionnaire survey related to evaluation of public perceptions to TDM measures.
- As stated preference, approach suffers from different biases, including justification and policy biases (Bhattacharjee, *et. al.* 1997) and people's behaviour may be different from stated intentions (Ben-Akiva and Morikawa, 1990). Therefore, there is a need of post study after implementation of any measure to check actual behaviour of people.
- Further studies should also focus on qualitative approach with large sample size in assessing the social-cognitive aspects of travel behaviour, and behavioural outcomes of TDM measures.

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RESEARCH PUBLICATIONS

1. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. (2013) Factors Influencing the Acceptability of Travel Demand Management (TDM) Policies in Lahore: Application of Behavioural Theories. ***EASTS*** **(Accepted for Journal)**
2. **Javid, M.A.**, Okamura, T., Nakamura, F., and Wang, R. (2012) A Study on Commuter's Preferences and Satisfaction towards Public Transportation: A Case of Para-Transit Service in Lahore, Pakistan, *Journal of International City Planning*, The City Planning Institute of Japan, pp. 225-236.
3. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. Attitudinal Evaluation of People's Preferences towards Public Transport in Lahore: Importance of Situational Factors, Mobility Restrictions, and Incentives. ***JSCE*** **(Under review)**
4. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. (2013) Public attitudes towards TDM strategies in Lahore, Pakistan: Importance of lifestyles, social and travel related beliefs, *Proceedings of 13th World Conference on Transport Research* (WCTR), July 15-18, 2013, Rio, Brazil. **(Under review for Journal)**
5. **Javid, M.A.**, Okamura, T., Nakamura, F., and Wang, R. (2013) Analysis of Road User's Perceptions to Radio Traffic Information in Lahore, Pakistan, *Proceedings of 20th ITS World Congress*, October 15-18, 2013, Tokyo, Japan. **(Accepted)**
6. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. Understanding travel attitudes of private car, motorcycle and public transport users and evaluating the relevant strategies: A Case of Lahore, Pakistan. *Transportation* **(Under review)**
7. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. Evaluation of Public Satisfaction with Daewoo Urban Bus Service in Lahore, Pakistan, *Pakistan Journal of Engineering and Applied Sciences.* **(Under review)**
8. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. Commuter's Perceptions to Travel Demand Management Measures in Lahore: Analysis and Implications, *Proceedings of the Pakistan Academy of Sciences.* **(Under review)**
9. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. (2012) Methodology for Evaluating the Driver's Attitudes towards Transportation Demand Management Measures in Lahore, Pakistan. *Journal of Recent Trends in Civil Engineering and Technology*, 2(3), pp. 45-59.
10. **Javid, M.A.**, Nakamura, F., Okamura, T. and Wang, R. (2011) Road use perceptions to radio traffic information service in Lahore, Pakistan, *Proceedings of 13th International Summer Symposium*, Japan Society of Civil Engineers, pp. 251-254.
11. **Javid, M.A.**, Okamura, T., Nakamura, F., Tanaka, S. and Wang, R. (2012) Evaluation of Public Attitudes towards Private Car and Public Transport in Lahore, Pakistan, *Proceedings of 46th Infrastructure Planning Conference*, Japan Society of Civil Engineers, CD-ROM, November 2-4, 2012, Saitama, Japan.
12. **Javid, M.A.**, Okamura, T., Nakamura, F., and Wang, R. Analysis and Modelling of Commuter's Perceptions to Radio Traffic Information In Lahore, Pakistan, *Proceedings of 44th Infrastructure Planning Conference*, Japan Society of Civil Engineers, CD-ROM, November 25-26, 2011, Gifu, Japan.

APPENDIXES

Appendix A-I: Questionnaire related to traffic radio for commuters

(Email survey was conducted in May/ June and field survey in September 2011)

Laboratory of Transportation and Urban Engineering,
Department of Civil Engineering, Yokohama National University, Japan

Area/intersection: _____ Questionnaire No: _____

Distributer/Interviewer: _____ Date: _____

Method: (☐Interview; ☐drop/pick) Time: _____

Questionnaire Survey by Mr. Muhammad Ashraf Javid (Ph.D. Student at Yokohama National University, Japan and Lecturer at University of Engineering and Technology, Lahore)

This questionnaire survey is being conducted to know your perceptions to FM 88.60 traffic radio in Lahore city. This traffic radio was started by Lahore traffic police in July 2009 to provide up-to-date information to the road users about traffic conditions on road. Your response will be good contribution to this research and this questionnaire consists of total two pages. It is assured that any information or data declared here will remain ***Fully Confidential*** and will be used only for ***Research Purpose.***
"***Thanking you in anticipation***"

PART 1: Trip Information

Please write the require information in the given space or mark ✔inside ☐ for your best option.

			5-7 days per week	3-4 days per week	1-2 days per week	A few times a month	A few times a year	Never
1.	How often do you make trips for following purposes?	Work/Business/study	☐	☐	☐	☐	☐	☐
		Shopping	☐	☐	☐	☐	☐	☐
		Recreation, or others	☐	☐	☐	☐	☐	☐
2.	How often do you make trips with following modes for above purposes?	Personal Car	☐	☐	☐	☐	☐	☐
		Office car	☐	☐	☐	☐	☐	☐
		Office bus/van	☐	☐	☐	☐	☐	☐
		Motorcycle	☐	☐	☐	☐	☐	☐
		Auto-rickshaw	☐	☐	☐	☐	☐	☐
		Public bus	☐	☐	☐	☐	☐	☐
		Public wagon/minibus	☐	☐	☐	☐	☐	☐
		Motorcycle Rickshaw	☐	☐	☐	☐	☐	☐
		Campus Bus	☐	☐	☐	☐	☐	☐
		Walk or Bicycle	☐	☐	☐	☐	☐	☐
3.	What is your morning work/business/study trip timing?		Starting:_____ Ending: _____					

PART 2: Lahore Traffic Police has initiated FM 88.60 traffic information channel for public awareness about traffic. The purpose of this part is to know level of exposure with traffic radio and level of satisfaction with its service attributes. (www.rasta.pk)

Section 2.1: Please mark ✔ inside ☐ for your best option

1	Arrival time flexibility in morning trip	1.☐ Possible to arrive late 2.☐ Impossible to arrive late
2	Availability of alternative routes in most usual daily trip	1.☐ Yes, Available 2.☐ Not Available
3	Means or way of listening FM 88.60 traffic radio	☐ None ☐ cell phone ☐ on-board radio in vehicle ☐ internet
4	What is your pre-trip or at home listening tendency of traffic radio?	1.☐ Never 2.☐ Frequently 3.☐ Regularly
5	Influence on trip attributes of pre-trip traffic information	1.☐ Never 2.☐ A few times 3.☐ Regularly
6	What do you think about your response to traffic information at home or pre-trip?	1. ☐ Ignore the information 2. ☐ Change the route 3. ☐ Change departure time 4. ☐ follow other mode
7	Response of drivers who prefer to change departure time in above question	1. ☐ Leave earlier-usual route 2. ☐ leave late-usual route 3. ☐ Leave early-another route 4. ☐ leave late-another route
8	What is your en-route listening tendency of traffic radio?	1. ☐ Never 2.☐ Frequently 3.☐ Regularly
9	What do you think about your response to radio information en route?	☐ Change of route ☐ No change of route
10	How much time reduction do you experience when you change departure time or route due to traffic congestion?	1. ☐ 0 -5 min 2. ☐ 6 -10 min 3. ☐ 11 – 15 min 4. ☐ 16 – 20 min 5. ☐ More than 20 min

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11	What is your main purpose to listen FM 88.60 traffic radio?	1. ☐ None 2. ☐ Route conditions 3. ☐ Weather information 4. ☐ Entertainment 5. ☐ Train information
12	How often will you use traffic radio as a traffic information service in future in case of improvement?	☐will not use ☐will start to use ☐will use as present ☐will use more frequently

Section 2.2: The aim of this part is to know your **level of satisfaction** with service attributes *and* **Level of Importance with the improvement** of FM 88.60 traffic radio service.

1= Very Unsatisfied/ Unimportant, 2 = Unsatisfied/ Unimportant, 3 = Neutral, 4 = Satisfied/ Important, 5 = Very satisfied/ important

	Please en-circle ○ around your best option	**Level of Satisfaction** Very unsatisfied → Very satisfied						**Level of Importance** Very unimportant → Very important				
1	Reliability or accuracy of information	1	2	3	4	5		1	2	3	4	5
2	The amount of detail or information given	1	2	3	4	5		1	2	3	4	5
3	Access to traffic information/Quality of radio signal	1	2	3	4	5		1	2	3	4	5
4	Broadcasting frequency of latest information	1	2	3	4	5		1	2	3	4	5
5	Geographical coverage (covers all important routes)	1	2	3	4	5		1	2	3	4	5
6	Overall performance of FM 88.60 radio traffic	1	2	3	4	5						

PART 3: Personal Information

Please write or report the required information in the given space or mark ✔inside ☐ for your best options.

1	Gender	☐ Male ☐ Female	Marital Status	☐ Single ☐ Married
3	Residence location	_____	What is your age?	_____ Years
4	Household members	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ more than 7		
5	Education level	1. ☐ Below high school 2. ☐ High school 3. ☐ Higher Secondary School 4. ☐ Diploma 5. ☐ Bachelor Level 6. ☐ Master and Higher		
5.	Occupation	1. ☐Student 2. ☐ General civil servant 3. ☐ Academic civil servant 4. ☐ Technical civil servant 5. ☐ Technical Private Employee 6. ☐ General Private Employee 7. ☐ Business or entrepreneur 8. ☐ Social worker 9. ☐ Others(_____)		
6.	Personal monthly income (In PKR)	1. ☐Below 10,000 2. ☐ 10,000–20,000 3. ☐ 21,000–30,000 4.☐ 31,000–40,000 5. ☐ 41,000 –70,000 6. ☐ 71,000 –100,000 7. ☐ More than 100,000		
7.	Household monthly income (In PKR)	1. ☐Below 10,000 2. ☐ 10,000–20,000 3. ☐ 21,000–40,000 4.☐ 41,000–70,000 5. ☐ 71,000 –100,000 6. ☐ 101,000 –150,000 7. ☐ More than 150,000		
8.	Household Car/Jeep/van	☐ None ☐ 1 unit ☐ 2 unit ☐ 3 or more	Do you drive?	☐ Yes ☐ No
9.	Household Motor Cycle	☐ None ☐ 1 unit ☐ 2 unit ☐ 3 or more	Do you drive?	☐ Yes ☐ No
10.	Do you have car-driving license?	☐ Yes ☐ No	Do you have motorcycle-driving license?	☐ Yes ☐ No
11.	How did you learn driving?	1. ☐ Self trained 2. ☐ Trained by family members/friends 3. ☐ Driving School 4. ☐ Others (_____)		

Thank you very much for your kind co-operation and support.

Appendix A-II: Questionnaire related to traffic radio for drivers

(Field survey was conducted in September 2011)

Laboratory of Transportation and Urban Engineering,
Department of Civil Engineering, Yokohama National University, Japan

Area/intersection: _____ Questionnaire No: _____

Distributer/Interviewer: _____ Date: _____

Method: (☐Interview; ☐drop/pick) Time: _____

Questionnaire Survey by Mr. Muhammad Ashraf Javid (Lecturer at University of Engineering and Technology, Lahore and Ph.D. Student at Yokohama National University, Japan)

This questionnaire survey is being conducted to know your opinion about your lifestyles and driving behavior, perception to demand management measures and FM 88.60 traffic radio in Lahore city. This traffic radio was started by Lahore traffic police in July 2009 to provide up-to-date information to the road users about traffic conditions on road. Your response will be good contribution to this research and this questionnaire consists of total two pages. It is assured you that any information or data declared here will remain ***Fully Confidential*** and will be used only for ***Research Purpose.*** ***"Thanking you in anticipation"***

PART 1: Personal and Driving Information

Please write the required things in the given space or mark ✔ inside ☐ for your best options.

1	Residence location	_____			
2	Gender	☐ Male ☐ Female	3	Marital Status	☐ Single ☐ Married
4	Age (years)	☐ Below 20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 50 -60 ☐ Above 60			
5	Household members	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ more than 7			
6	Education level	1. ☐ Below middle school 2. ☐ High school 3. ☐ Higher secondary school 4. ☐ Diploma 5. ☐ Bachelor Level 6. ☐ Master and Higher			
7	Personal monthly income (in Pak Rupees)	1. ☐ Below 10,000 2. ☐ 10,000 –15,000 3. ☐ 16,000 –20,000 4. ☐ 21,000 –25,000 5. ☐ 26,000 –30,000 6. ☐ More than 30,000			
8	Household monthly income (in Pak Rupees)	1. ☐ Below 10,000 2. ☐ 10,000 –20,000 3. ☐ 20,000 –30,000 4. ☐ 31,000 –40,000 5. ☐ 41,000 –50,000 6. ☐ More than 50,000			
9	Do you have driving license?	☐ Yes ☐ No	Driver of	☐Auto-Rickshaw ☐Taxi ☐Truck ☐ Others(___)	
10	Ownership of above driving vehicle	☐ None ☐ 1 unit ☐ 2 unit ☐ 3 or more than 3			
11	Driving frequency	☐ ≤ 3 days week ☐ 4-6 days a week ☐ Almost every day a week			
12	Number of driving hours per day	☐ Less than 4 ☐ 5 – 6 ☐ 7– 9 ☐ 10 - 12 ☐ More than 12			
13	Driving experience	_____ Years	On average how many miles you drive per day?		_____Km
14	How did you learn driving?	1. ☐ Self trained 2.☐ Trained by family members/friends 3. ☐ Driving School			
15	What do you do during your waiting hours?	1.☐ Sleep 2. ☐ Listen to radio 3. ☐Chat with fellow drivers 4. ☐ Smoke 5. ☐ Have tea/drink 6. ☐ Read newspaper/magazine 7. ☐ Others (_____)			

PART 2: Lahore Traffic Police has initiated FM 88.60 traffic information channel for public awareness about traffic. The purpose of this part is to know level of exposure with traffic radio and level of satisfaction with its service attributes. (www.rasta.pk)

Section 2.1: Please mark ✔ inside ☐ for your best option

1	Arrival time flexibility in morning trip	1.☐ Possible to arrive late 2.☐ Impossible to arrive late
2	Availability of alternative routes in most usual daily trip	1.☐ Yes, Available 2.☐ Not Available
3	Means or way of listening FM 88.60 traffic radio	☐ None ☐ cell phone ☐ on-board radio in vehicle ☐ internet
4	What is your pre-trip or at home listening tendency of traffic radio?	1.☐ Never 2.☐ Frequently 3.☐ Regularly
5	Influence on trip attributes of pre-trip traffic information	1.☐ Never 2.☐ A few times 3.☐ Regularly
6	What do you think about your response to traffic information at home or pre-trip?	1. ☐ Ignore the information 2. ☐ Change the route 3. ☐ Change departure time 4. ☐ follow other mode
7	Response of drivers who prefer to change departure time in above question	1. ☐ Leave earlier-usual route 2. ☐ leave late-usual route 3. ☐ Leave early-another route 4. ☐ leave late-another route
8	What is your en-route listening tendency of traffic radio?	1. ☐ Never 2.☐ Frequently 3.☐ Regularly
9	What do you think about your response to radio information en route?	☐ Change of route ☐ No change of route
10	How much time reduction do you experience when you change departure time or route due to traffic congestion?	1. ☐ 0 -5 min 2. ☐ 6 -10 min 3. ☐ 11 – 15 min 4. ☐ 16 – 20 min 5. ☐ More than 20 min

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11	What is your main purpose to listen FM 88.60 traffic radio?	1. ☐ None 2. ☐ Route conditions 3. ☐ Weather information 4. ☐ Entertainment 5. ☐ Train information
12	How often will you use traffic radio as a traffic information service in future in case of improvement?	☐will not use ☐will start to use ☐will use as present ☐will use more frequently

Section 2.2: The aim of this part is to know your **level of satisfaction** with service attributes *and* **Level of Importance with the improvement** of FM 88.60 traffic radio service.

1= Very Unsatisfied/ Unimportant, 2 = Unsatisfied/ Unimportant, 3 = Neutral, 4 = Satisfied/ Important, 5 = Very satisfied/ important

Please en-circle ○ around your best option		Level of Satisfaction						Level of Importance				
		Very unsatisfied → Very satisfied						Very unimportant → Very important				
1	Reliability or accuracy of information	1	2	3	4	5		1	2	3	4	5
2	The amount of detail or information given	1	2	3	4	5		1	2	3	4	5
3	Access to traffic information/Quality of radio signal	1	2	3	4	5		1	2	3	4	5
4	Broadcasting frequency of latest information	1	2	3	4	5		1	2	3	4	5
5	Geographical coverage (covers all important routes)	1	2	3	4	5		1	2	3	4	5
6	Overall performance of FM 88.60 radio traffic	1	2	3	4	5						

PART 3: Your opinions and Attitudes

The aim of this part is to know your opinion about your lifesytles and driver attitudes. Please show your **level of agreement** with each statement using following scale → 1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Somewhat Agree, 4 = Strongly Agree

3.1	Please en-circle ○ around your best option against each statement **Opinion about driving habits**	Strongly Disagree →			Strongly Agree
1	I remain calm and cool whenever there is a delay due to traffic congestion or an accident	1	2	3	4
2	I have intention to save fuel by switching vehicle to higher speed	1	2	3	4
3	I prefer to stop or take rest when I get tired	1	2	3	4
4	I do not mind when somebody teaches me how to drive	1	2	3	4
5	I do not mind when someone's vehicle tries to overtake my vehicle	1	2	3	4
6	I do not mind to cooperate with traffic police whenever there is violation of traffic rules	1	2	3	4
7	I frequently participate in emergency works during an accident	1	2	3	4
8	Safety of other vehicles during driving is my priority	1	2	3	4
9	Shortest travel time or route is my first priority	1	2	3	4
10	I have habit to interact with unknown people during driving	1	2	3	4
11	I do not afraid to drive in unsafe and unsecure surrounding	1	2	3	4
12	I do not want to disturb my driving schedule due to traffic congestion	1	2	3	4
13	I prefer to change travel route in case of traffic congestion	1	2	3	4
3.2	**Opinions and attitudes**				
14	I like to live in secure and safe surrounding	1	2	3	4
15	I am very keen to learn new things about traffic	1	2	3	4
16	It disturb me if I am forced to change in my routine	1	2	3	4
17	I prefer time saving to safety for trip decision	1	2	3	4
18	I prefer cost saving to time saving for trip decision	1	2	3	4
19	Advance traffic information would be very helpful to relieve traffic congestion	1	2	3	4
20	I have intentions to participate in traffic education and awareness programs	1	2	3	4
21	I would pay more road taxes in order to improve traffic conditions in the city	1	2	3	4
22	I support to put more carbon tax on gasoline (petrol) in order to protect environment	1	2	3	4
23	I support to increase road tax in order to reduce usage of private car or motorcycle	1	2	3	4
24	I feel moral responsibility to protect environment from the negative effects of traffic	1	2	3	4

Thank you very much for your kind co-operation.

2-2

Appendix B: Phase-I Questionnaire

(Field survey was conducted in September 2011)

Laboratory of Transportation and Urban Engineering,
Department of Civil Engineering, Yokohama National University, Japan

Area/intersection/Organization: _____ Questionnaire No: _____
Distributer/Interviewer: _____ Date: dd mm yyyy
Method: (☐ Interview; ☐ drop/pick) Time: _____

Questionnaire Survey by Mr. Muhammad Ashraf Javid (Ph.D. Student at Yokohama National University, Japan and Lecturer at University of Engineering and Technology, Lahore)

This questionnaire survey is being conducted to know your attitude and opinions towards trip making and lifestyle, opinion about public transport, and perception to demand management measures. Your response will be good contribution to this research and this questionnaire consists of total three (3) pages. It is assured you that any information or data declared here will remain ***Fully Confidential*** and will be used only for ***Research Purpose.*** ***"Thanking you in anticipation"***

PART 1: Trip Information

Please write the require information in the given space or mark ✔inside ☐ for your best option.

			5-7 days per week	3-4 days per week	1-2 days per week	A few times a month	A few times a year	Never
1.	How often do you make trips for following purposes?	Work/Business/study	☐	☐	☐	☐	☐	☐
		Shopping	☐	☐	☐	☐	☐	☐
		Recreation, or others	☐	☐	☐	☐	☐	☐
2.	How often do you make trips with following modes for above purposes?	Personal Car	☐	☐	☐	☐	☐	☐
		Office car	☐	☐	☐	☐	☐	☐
		Office bus/van	☐	☐	☐	☐	☐	☐
		Motorcycle	☐	☐	☐	☐	☐	☐
		Auto-rickshaw	☐	☐	☐	☐	☐	☐
		Public bus	☐	☐	☐	☐	☐	☐
		Public wagon/minibus	☐	☐	☐	☐	☐	☐
		Motorcycle Rickshaw	☐	☐	☐	☐	☐	☐
		Campus Bus	☐	☐	☐	☐	☐	☐
		Walk or Bicycle	☐	☐	☐	☐	☐	☐
3.	What is your morning work/business/study trip timing?		Starting: _____		Ending: _____			

PART 2: Your opinions and Attitudes

The aim of this part is to know your opinion and attitudes towards your trip making and living style. Show your **level of agreement** with each statement using ➡ 1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Somewhat Agree, 4 = Strongly Agree

	Please en-circle ○ around your best option against each statement	Strongly Disagree ➡			Strongly Agree
2.1	**Opinions about trip making**				
1	**I prefer time saving to safety** for my trip decision	1	2	3	4
2	**I prefer time saving to cost saving** for my trip decision	1	2	3	4
3	**I prefer reliablity** (schedule and travel time) **to cost saving** for my trip decision	1	2	3	4
4	**I prefer reliablity** (schedule and travel time) **to comfort** for my trip decision	1	2	3	4
5	**I prefer reliablity** (schedule and travel time) **to time saving** for my trip decision	1	2	3	4
6	**I prefer comfort to cost saving** for my trip decision	1	2	3	4
7	**I prefer comfort to time saving** for my trip decision	1	2	3	4
8	I select mode that can protect me from traffic accident for the 1st reason	1	2	3	4
2.2	**General Opinions and Attitudes**				
9	It is better for me to have a car	1	2	3	4
10	I like to live in secure and safe surrounding	1	2	3	4

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2.2	**Please en-circle ○ around your best option against each statement** **General Opinions and Attitudes**	Strongly Disagree →			Strongly Agree
11	I like to work/study in secure and safe surrounding	1	2	3	4
12	I like to live in joint family system	1	2	3	4
13	I prefer to live near to my work/study place	1	2	3	4
14	I avoid to interact with unknown people	1	2	3	4
15	Shorter travel time is the first priority	1	2	3	4
16	Cheaper fare is the first priority	1	2	3	4
17	I am very keen to change my lifestyle with change of income	1	2	3	4
18	It disturbs me if I am forced to change in my routine	1	2	3	4
19	I do not want to disturb my schedule due to traffic congestion	1	2	3	4
20	Travelling mode/ means of transportation effects my personality image	1	2	3	4
21	I do not want to take longer trips for shoping	1	2	3	4
22	I like ride sharing with my friends or colleagues going for party or recreation	1	2	3	4
23	I prefer ride sharing with my family members going to work or study	1	2	3	4
24	I prefer to walk or use bicycle for a trip length less than 1-2 km	1	2	3	4
25	For long trips, I like to use car or taxi/ auto rickshaw	1	2	3	4
26	Even if I have or will own a car, I do/would use public transport sometimes	1	2	3	4
27	When traffic is congested, I avoid to use personal vehicle or auto-rickshaw/taxi	1	2	3	4
28	I prefer to change means of transportation due to traffic congestion	1	2	3	4
29	I prefer to change travel route in case of traffic congestion	1	2	3	4
2.3	**Opinions to TDM measures and personal intentions to reduce use or do not use of private vehicle**				
30	Advance traffic information would be very helpful to relieve traffic congestion	1	2	3	4
31	I have intentions to participate in traffic education and awareness programs	1	2	3	4
32	I would pay more road taxes in order to improve traffic conditions in the city	1	2	3	4
33	I have intention to do online/ tele-work (home-based work) if there will be opportunity	1	2	3	4
34	I have intention to use office/ school based transport service from organization/institutions/companies	1	2	3	4
35	I support to increase parking charges in order to reduce traffic congestion in the city	1	2	3	4
36	I support to put more carbon tax on gasoline (petrol) in order to protect environment	1	2	3	4
37	I would use public transport if there is better mode like rapid rail mass transit/ bus lanes	1	2	3	4
38	I personally feel responsible to ***do not use/ reduce usage of*** private vehicle in future in order to reduce traffic congestion	1	2	3	4
39	I personally feel responsible to ***do not use/reduce usage of*** private vehicle in order to decrease negative effects on the environment	1	2	3	4
2.4	**Q. 40 to Q. 49 is only for use car and motorcycle users**				
40	Using car/motorcycle increases my work efficiency	1	2	3	4
41	I do not mind to share my personal vehicle with friends or colleagues going to work/study/business trip	1	2	3	4
42	It is acceptable for me to use public bus for short trips like 3-5 km	1	2	3	4
43	It is acceptable for me to use public transport, if parking facility is not available at destination or work place	1	2	3	4
44	It is preferable for me to use public transport, if parking charges are very high	1	2	3	4
45	I prefer to use air-conditioned bus whenever I need to use public transport	1	2	3	4
46	It is not possible for me to use public transport during rain or hot weather	1	2	3	4
47	I will prefer to use personal vehicle even if other modes offer shorter travel time	1	2	3	4
48	It is not possible for me to use public transprort when I have trip other than work/ study	1	2	3	4
49	In any case, I try to avoid to use public trasnport	1	2	3	4

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PART 3: The aim of this section is to know your ***Level of Satisfaction*** with Public Transport (bus and minibus) modes in Lahore. Only two transport services are considered in this part consisting of Daewoo bus and wagon/minibus service. Kindly use the following four-point scale for evaluation. ➡ **1= Not satisfied, 2= less satisfied, 3= satisfied and 4= totally satisfied**

Please en-circle ○ around your best option in each row for both services.		**Daewoo City Bus** 				**Wagon** 			
		Not satisifed ➡			Totally satisfied	Not satisifed ➡			Totally satisfied
1	Routes coverage	1	2	3	4	1	2	3	4
2	Punctuality of service	1	2	3	4	1	2	3	4
3	Travel time reliability	1	2	3	4	1	2	3	4
4	Frequency of service	1	2	3	4	1	2	3	4
5	Travel cost (fare)	1	2	3	4	1	2	3	4
6	Attitude of driver and conductor	1	2	3	4	1	2	3	4
7	Safety and security	1	2	3	4	1	2	3	4
8	Waiting time	1	2	3	4	1	2	3	4
9	Comfort level	1	2	3	4	1	2	3	4
10	Convenience level	1	2	3	4	1	2	3	4
11	Physical condition of vehicle	1	2	3	4	1	2	3	4
12	Routes and bus schedule information	1	2	3	4	1	2	3	4
13	Walking time to stop	1	2	3	4	1	2	3	4
14	Physical conditions of stop (cleaning, shelter, lightening)	1	2	3	4	1	2	3	4
15	Ticket and fare collection system	1	2	3	4	1	2	3	4
16	Overall evaluation of performance	1	2	3	4	1	2	3	4

PART 4: Personal Information

Please write the require information in the given space or mark ✔inside ☐ for your best options.

1	Gender	☐ Male ☐ Female	Marital Status	☐ Single ☐ Married	
3	Residence location	_____	What is your age?	_____ Years	
4	Household members	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ more than 7			
5	Education level	1. ☐ Below high school 2. ☐ High school 3. ☐ Higher Secondary School 4. ☐ Diploma 5. ☐ Bachelor Level 6. ☐ Master and Higher			
5.	Occupation	1. ☐ Housewife 2. ☐ Student 3. ☐ General civil servant 4. ☐ Academic civil servant 5. ☐ Technical civil servant 6. ☐ Technical Private Employee 7. ☐ General Private Employee 8. ☐ Business or entrepreneur 9. ☐ Social worker 10. ☐ Others(_____)			
6.	Personal monthly income (In PKR)	1. ☐ Below 10,000 2. ☐ 10,000–20,000 3. ☐ 21,000–30,000 4. ☐ 31,000–40,000 5. ☐ 41,000 –70,000 6. ☐ 71,000 –100,000 7. ☐ More than 100,000			
7.	Household monthly income (In PKR)	1. ☐ Below 10,000 2. ☐ 10,000–20,000 3. ☐ 21,000–40,000 4. ☐ 41,000–70,000 5. ☐ 71,000 –100,000 6. ☐ 101,000 –150,000 7. ☐ More than 150,000			
8.	Household Car/Jeep/van	☐ None ☐ 1 unit ☐ 2 unit ☐ 3 or more	Do you drive?	☐ Yes ☐ No	
9.	Household Motor Cycle	☐ None ☐ 1 unit ☐ 2 unit ☐ 3 or more	Do you drive?	☐ Yes ☐ No	
10.	Do you have car driving license?	☐ Yes ☐ No	Do you have motorcycle driving license?	☐ Yes ☐ No	
11.	How did you learn driving?	1. ☐ Self trained 2. ☐ Trained by family members/friends 3. ☐ Driving School 4. ☐ Others (_____)			

Thank you very much for your kind Cooperation and Contribution to this Research.

Appendix C: Phase-II Questionnaire

(Field survey was conducted in September/ October 2012)

Laboratory of Transportation and Urban Engineering,
Department of Civil Engineering, Yokohama National University, Japan

Area/ Organization: _____ Questionnaire No: _____

Distributer/Interviewer: _____ Method: (☐ Interview; ☐ drop/pick) Date: dd mm yyyy

Questionnaire Survey by Mr. Muhammad Ashraf Javid
(Doctoral Course Student at Yokohama National University, Japan and Lecturer at DTEM, UET, Lahore)

This questionnaire survey is being conducted in Lahore to know your opinion about your lifestyles, travel attitudes and preferences towards private car and public transport as well as opinion about the congestion mitigation measures in Lahore city. Your response will be a good contribution to this research and this questionnaire consists of total 4 pages. It is assured you that any information declared here will remain ***Fully Confidential*** and will be used only for ***Research Purpose.*** ***"Thanking you in anticipation"***

Part 1: Please report about your travel information as requested below. **Write in ----- or mark ✔inside ☐ for your best option.**

1	How usually do you travel from **home** to **office or study place**? Please report all **modes in 4th column** that you use in your one way trip from below 2nd and 3rd column and **average travel time for each mode in last column.**				
Travel mode options	[A] Walk	[G] Pick and drop by other on MC	Please write **'Letter'** from 2nd and 3rd column for each mode	Average travel time of each mode	
	[B] Bicycle	[H] Auto-rickshaw/taxi			
	[C] Drive private car	[I] Campus/office transport	**Example. first mode {--H---}**	**Example. --15--min**	
	[D] Drive office car	[J] Motorcycle rickshaw (Qingqi)	First mode {---------}	----------minutes	
	[E] Drive motorcycle (MC)	[K] Public wagon/minibus	2nd mode, if any {---------}	----------minutes	
	[F] Pick and drop by others on car	[L] Non-AC public bus	3rd mode, if any {---------}	----------minutes	
		[M] AC public bus	4th mode, if any {---------}	----------minutes	
2	How often do you make trip per week with above reported modes?		☐5-7 day ☐3-4 day ☐1-2 day ☐a few times a month		
3	What is total travel cost incurred for your daily one way trip **from home to office/ school** with above modes? (Including fare, fuel, toll, parking, etc)		----------PKR		
4	What is the approximate length of your daily one way trip **from home to office/ school**?		----------Km		

Part 2: The aim of this part is to know your **Level of Agreement** for your lifestyles, and attitudes towards car and public transport. Please answer all the questions of **Part 2** using **6 point scale** as given in front table **considering your current and future intentions.**

Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1	2	3	4	5	6

Part 2 (A)	Please tell us your **Level of Agreement** about your lifestyles and travel preferences and **en-circle** ○ around your best option for each statement	Strongly Disagree					Strongly Agree
Example:	Religious values are important to me in traveling	1	2	3	4	(5)	6
1	Social power is a guiding principle of my life	1	2	3	4	5	6
2	Wealth is a guiding principle of my life	1	2	3	4	5	6
3	Travelling schedule of other family members does not give me enough freedom in travel	1	2	3	4	5	6
4	Obeying religious and social values are important to me in travelling	1	2	3	4	5	6
5	I prefer a mean (mode) of transportation which gives flexibility in route choice	1	2	3	4	5	6
6	I like a travel that allows me to do other acts on the way (e.g. shopping, drop children at school)	1	2	3	4	5	6
7	Having a car is a status symbol to me	1	2	3	4	5	6
8	I like to travel by public transport because I can interact with other people	1	2	3	4	5	6
9	I like to travel by public transport because I can read newspaper and books	1	2	3	4	5	6
10	People who are important to me always encourage me to use public transport because it is safer	1	2	3	4	5	6
11	If I use public transport, my friends/colleagues appreciate me because it is environmental friendly	1	2	3	4	5	6
12	I feel uncomfortable being around unknown people whenever I use public transport	1	2	3	4	5	6
13	For me, it is difficult to use public transport in everyday life	1	2	3	4	5	6
14	If I use public transport only, I do/would feel restricted in travelling	1	2	3	4	5	6
15	I like to travel by public transport because I feel more safe from accident	1	2	3	4	5	6
16	I think, car gives a lot of freedom in travelling	1	2	3	4	5	6
17	Excessive use of car deteriorates (destroys) the urban quality of life and environment	1	2	3	4	5	6
18	Car usage causes shortage of scarce (rare) natural resources, for example oil and gas	1	2	3	4	5	6
19	Car usage is a major cause of traffic congestion	1	2	3	4	5	6

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20	I am/would equally responsible for traffic congestion caused by use of private car	1 2 3 4 5 6
21	I feel joint-responsibility for the consumption of natural resources such as oil and gas	1 2 3 4 5 6
22	I feel equal responsibility for degradation of environment due to increase in traffic	1 2 3 4 5 6
23	I feel morally responsible for betterment of urban environment and society	1 2 3 4 5 6
24	I feel moral responsibility to preserve natural resources such as oil and gas	1 2 3 4 5 6
25	I feel that I can preserve environemnt by reducing car usage or not using car and I am ready to do	1 2 3 4 5 6

Part 3: Please show your **level of agreement** with each policy measures as per conditions associated with each statement by using same scale as in previous part. In answering all the questions, **kindly consider your future preference of car ownership and its usage.**
Please en-circle ○ around your best option against each statement using 6 point scale as given in first two row of table.

Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree	Strongly Disagree → Strongly Agree
1	2	3	4	5	6	

1	To improve air quality, I am willing to buy and use an energy efficient vehicle (e.g. electric car)			1 2 3 4 5 6
2	I would support the government policy on provision of office based transport for employees/workers from organizations or institutions	a.	For reduction of traffic congestion	1 2 3 4 5 6
		b.	For reduction of air pollution	1 2 3 4 5 6
		c.	and I am willing to use it	1 2 3 4 5 6
		d.	and I am willing to use because it will reduce travel cost	1 2 3 4 5 6

3	What is your willingness to pay taxes for the development of public transport and willingness to use it for different conditions												
	Please en-circle ○ around your best option in each row both for willingness to pay and use against each condition.			I am willing to use improved public transport						I am willing to pay taxes for the development of public transport					
	a.	For reduction of traffic congestion	1	2	3	4	5	6	1	2	3	4	5	6
	b.	For reduction of air pollution	1	2	3	4	5	6	1	2	3	4	5	6
	c.	If public transport is more reliable than private car	1	2	3	4	5	6	1	2	3	4	5	6
	d.	For less travel cost as compared to car	1	2	3	4	5	6	1	2	3	4	5	6
	e.	For shorter travel time as compared to car	1	2	3	4	5	6	1	2	3	4	5	6

4 Let suppose local government has plan to **double the travel cost of car use only in order to reduce traffic congestion and environmental problems**. **For example:** increasing the **cost of parking**, **fuel taxes**, **road taxes** (toll), and **annual car registration taxes**. It means that you need to pay **100%** more than current travel cost. **If such policy is implemented then what will be your response and intention considering increase in travel cost and reduction in congestion and air pollution.** Please also consider that reduction in congestion and air pollution would **reduce your travel time and health cost.**
Kindly en-circle ○ around your best option in each row of '**A**' and '**B**' for increase in all four categories. Please follow example.

I would accept increase in ----	Parking charges	Road tax (toll)	Carbon tax on petrol	Car registration taxes
for reduction of air pollution	1 2 3 4 (5) 6	1 2 (3) 4 5 6	1 2 3 4 5 (6)	1 2 3 4 (5) 6

A	**I would accept increase in ---**	Parking charges	Road tax (toll)	Carbon tax on petrol	Car registration taxes
a.	For reduction of congestion	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
b.	For reduction of air pollution	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
c.	If collected charges/taxes use to improve public transport	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6

B	**Due to increase in ----------**	Parking charges	Road tax (toll)	Carbon tax on petrol	Car registration taxes
a.	I would travel by car as usual	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
b.	I would travel less by car	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
c.	I would prefer to travel by improved public transport	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
d.	I would travel with car by sharing travel cost with friends	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
e.	I would prefer to use available	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6

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Part 4: This part aims to know your general beliefs about service quality factors of private car and public transport (irrespective of modes).

Please show your opinion for two opposite adjective of each attributes and **en-circle ◯around your best (single) option in each row.**

		1 & 2 go to this column	Strongly	Somewhat	Neutral	Somewhat	Strongly	4 & 5 go to this column
Example		Inconvenient	1	2	3	④	5	Convenient
		Personal	1	2	③	4	5	Public
Lahore urban Public transport	1	Slow	1	2	3	4	5	Fast
	2	Expensive	1	2	3	4	5	Cheap
	3	Inconvenient	1	2	3	4	5	Convenient
	4	Uncomfortable	1	2	3	4	5	Comfortable
	5	Unreliable	1	2	3	4	5	Reliable
	6	Risky	1	2	3	4	5	Safe
	7	Traditional	1	2	3	4	5	Advanced
	8	Public	1	2	3	4	5	Personal
	9	Noisy	1	2	3	4	5	Calm
	10	Unattractive	1	2	3	4	5	Attractive
	11	Crowded	1	2	3	4	5	Un-crowded
	12	Boring	1	2	3	4	5	Exciting
	13	Un-friendly	1	2	3	4	5	Friendly
	14	Unrespectable	1	2	3	4	5	Respectable
	15	Inelegant	1	2	3	4	5	Elegant
	16	Unhealthy humanly	1	2	3	4	5	Healthy humanly
	17	Stressful	1	2	3	4	5	Relaxed
	18	Low social value	1	2	3	4	5	High social value
	19	Environmentally destructive	1	2	3	4	5	Environmental friendly
Private Car	1	Slow	1	2	3	4	5	Fast
	2	Expensive	1	2	3	4	5	Cheap
	3	Inconvenient	1	2	3	4	5	Convenient
	4	Uncomfortable	1	2	3	4	5	Comfortable
	5	Unreliable	1	2	3	4	5	Reliable
	6	Risky	1	2	3	4	5	Safe
	7	Traditional	1	2	3	4	5	Advanced
	8	Public	1	2	3	4	5	Personal
	9	Noisy	1	2	3	4	5	Calm
	10	Unattractive	1	2	3	4	5	Attractive
	11	Crowded	1	2	3	4	5	Un-crowded
	12	Boring	1	2	3	4	5	Exciting
	13	Un-friendly	1	2	3	4	5	Friendly
	14	Unrespectable	1	2	3	4	5	Respectable
	15	Inelegant	1	2	3	4	5	Elegant
	16	Unhealthy humanly	1	2	3	4	5	Healthy humanly
	17	Stressful	1	2	3	4	5	Relaxed
	18	Low social value	1	2	3	4	5	High social value
	19	Environmentally destructive	1	2	3	4	5	Environmental friendly

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Part 5: The aim of this part is to know your preferences to use car and public transport under different conditions. ***If you do not have car in your house,*** **please suppose you have one car in your house.** Suppose you go to a place, which can be accessed by Daewoo Bus and New Bus Rapid Transit (BRT) Line and answer all questions as listed below. The Key features of Daewoo Bus and Bus Rapid Transit are given below. **Please tell us about your prefer travel options from alternatives as given below against each statement.**

Daewoo City Bus (DCB)	Bus Rapid Transit (BRT)
• Diesel bus • Frequency vary (10-15 min) • Air-conditioned bus • Mixed with traffic • Well dressed staff • Manual fare collection	 	• CNG bus • Every 2-4 mint service • Air-conditioned bus • Separate bus lane on road • Well dressed staff • Electronic fare collection	

Alternatives

1. Absolutely **car**
2. Usually **car** but also accept **public transport** for sometime
3. Both **car** and **public transport** as per situation
4. Usually **public transport** but not every time
5. Absolutely **public transport**

If you choose option 2, 3, 4 and 5, then which public transport mode would you use? Please select one at that line and mark 'X or ✔ inside box

Please en-circle ◯around your best option in each row.

Example: When parking is very far from your destination place		1	2	3	(4)	5	☐DCB ☒BRT
1	When your purpose is to go office/school/university alone	1	2	3	4	5	☐DCB ☐BRT
2	When your purpose is to go office/school/university with family members	1	2	3	4	5	☐DCB ☐BRT
3	When your purpose is to go office/school/university with friends	1	2	3	4	5	☐DCB ☐BRT
4	When you need to travel with elder family members	1	2	3	4	5	☐DCB ☐BRT
5	When parking is limited at destination place	1	2	3	4	5	☐DCB ☐BRT
6	When parking is very far from your destination place	1	2	3	4	5	☐DCB ☐BRT
7	When the parking fee for car is about 100 Rs. per 3 hours	1	2	3	4	5	☐DCB ☐BRT
8	When you need to pay a road tax of 100 Rs. for using car each time	1	2	3	4	5	☐DCB ☐BRT
9	When entry of car is restricted in public transport service area	1	2	3	4	5	☐DCB ☐BRT
10	When you can reach many important destinations directly by public transport	1	2	3	4	5	☐DCB ☐BRT
11	When travel cost by public transport is half of car	1	2	3	4	5	☐DCB ☐BRT
12	When travel time by public transport is 10 minutes less than car travel time	1	2	3	4	5	☐DCB ☐BRT
13	When seat is assured in public transport with same travel cost as car	1	2	3	4	5	☐DCB ☐BRT
14	When public transport is more reliable mode than private car	1	2	3	4	5	☐DCB ☐BRT
15	When seat is assured in public transport with same travel time as car	1	2	3	4	5	☐DCB ☐BRT
16	When you feel morally obliged to do not use car for reduction in congestion	1	2	3	4	5	☐DCB ☐BRT
17	When you feel morally obliged to protect environment from air pollution	1	2	3	4	5	☐DCB ☐BRT
18	When you feel morally obliged to preserve natural resources e.g. oil, gas	1	2	3	4	5	☐DCB ☐BRT

Part 6: Please report your personal information as listed below and **mark ✔inside ☐ for your appropriate option(s).**

1	Gender	☐ Male ☐ Female	2	Marital Status	☐ Single ☐ Married
3	Household members	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ More than 8			
4	What is your age? (years)	☐ under 20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ more than 60			
5	What is your education?	☐Below High school ☐High school ☐F.Sc. /F.A. ☐Diploma ☐Bachelor ☐Master or higher			
6	What is your occupation?	☐Student ☐Civil employee ☐Private employee ☐Business ☐Others			
7	What is your personal income per month? (PKR)	☐below 10,000 ☐11,000-15,000 ☐16,000-20,000 ☐21,000-25,000 ☐26,000-30,000 ☐31,000-40,000 ☐41,000-60,000 ☐61,000-80,000 ☐81,000-100,000 ☐More than 100,000			
8	What is your household income per month? (PKR)	☐below 10,000 ☐11,000-15,000 ☐16,000-20,000 ☐21,000-25,000 ☐26,000-30,000 ☐31,000-40,000 ☐41,000-60,000 ☐61,000-80,000 ☐81,000-100,000 ☐More than 100,000			
9	Household vehicle ownership?	☐None ☐Motorcycle ☐Car	10	Do you have driving license?	☐Yes ☐No
11	Which vehicle do you drive?	☐None ☐Motorcycle ☐Car	12	Do you live in joint family?	☐Yes ☐No

Thank you very much for your cooperation and support to this research

4-4

Appendix D: Detailed Interviews Questions

(Conducted in September/ October 2012)

Laboratory of Transportation and Urban Engineering,

Department of Civil Engineering, Yokohama National University, Japan

Organization: _____ Interviewees No: _____

Interviewer: Muhammad Ashraf Javid Date: dd mm yyyy

Interviews by Mr. Muhammad Ashraf Javid

(Doctoral Course Student at Yokohama National University, Japan and Lecture in DTEM, UET, Lahore)

This interview is being conducted in Lahore to know your opinions about your travel attitudes and preferences towards private car, motorcycle and public transport modes as well as opinions about congestion mitigation measures in Lahore city. Your response will be good contribution to this research. It is assured you that any information declared here will remain ***Fully Confidential*** and will be used only for ***Research Purpose.*** ***"Thanking you in anticipation"***

Part 1: Please report your personal information as listed below. **Write ----- or mark ✔inside ☐ for your best option.**

1	Gender	☐ Male ☐ Female	2	Marital Status	☐ Single ☐ Married
3	Household members	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ More than 8			
4	What is your age? (years)	☐ under 20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ more than 60			
5	What is your education?	☐Below High school ☐High school ☐F.Sc. /F.A. ☐Diploma ☐Bachelor ☐Master or higher			
6	What is your occupation?	☐Student ☐Civil employee ☐Private employee ☐Business ☐Others			
7	What is your personal income per month? (PKR)	☐below 10,000 ☐11,000-15,000 ☐16,000-20,000 ☐21,000-25,000 ☐26,000-30,000 ☐31,000-40,000 ☐41,000-60,000 ☐61,000-80,000 ☐81,000-100,000 ☐More than 100,000			
8	What is your household income per month? (PKR)	☐below 10,000 ☐11,000-15,000 ☐16,000-20,000 ☐21,000-25,000 ☐26,000-30,000 ☐31,000-40,000 ☐41,000-60,000 ☐61,000-80,000 ☐81,000-100,000 ☐More than 100,000			
9	Household vehicle ownership?	☐None ☐Motorcycle [--] ☐Car [--]	10	Do you have driving license?	☐Yes ☐No
11	Which vehicle do you drive?	☐None ☐Motorcycle ☐Car	12	Do you live in joint family?	☐Yes [---------] ☐No

13 How do you go usually from **home** to **office or study place**? Please report all modes that you use in your one way trip.

Travel mode options			**Exp. first mode {--H---}**	**Exp. --15---min**
	[A] Walk	**[G]** Pick and drop by other on MC		
	[B] Bicycle	**[H]** Auto-rickshaw/taxi	1st mode {---------}	----------minutes
	[C] Drive private car	**[I]** Campus/office transport	2nd mode, if any {---------}	----------minutes
	[D] Drive office car	**[J]** Motorcycle rickshaw (Qingqi)	3rd mode, if any {---------}	----------minutes
	[E] Drive motorcycle (MC)	**[K]** Public wagon/minibus	4th mode, if any {---------}	----------minutes
	[F] Pick and drop by others on car	**[L]** Non-AC public bus **[M]** AC public bus	5th mode, if any {---------}	----------minutes

14	What is total travel cost incurred for your one way trip with above modes? (Including fare, fuel, toll, parking, etc)	----------PKR
15	What is the approximate length of your daily one way trip from home to office/ school?	----------Km
16	How often you make trip per week with car?	☐1-2 day ☐3-4 day ☐5-7 day ☐a few times a month

Part 2: Please answer the questions regarding different aspects of your current travel behavior or mode and stated preferences under specific conditions.

Common questions from all mode users	
1	What are the factors generally you consider in your daily travelling?
2	What are the main reasons of using current mode (car/ motorcycle/ auto-rickshaw/ public transport modes / non-motorized modes) for your daily travel?
3	What kinds of problems do you face in using current mode or what are the disadvantages in using current travel mode?
4	What are the key features of a good public transport mode in your perspective that can attract you to use? Or What should be the quality of service of public transport that can encourage you to use it?
5	Which public transport mode development would you support in Lahore city and why? (Bus based or rail based)
6	If service quality level of public transport is made up to your demands as you mentioned in question 4, then, how often will you use it? ☐Never ☐Almost never ☐sometimes/occasionally ☐Almost always ☐Always/every time
7	If there is a transport service from your office or organization or institution such as wagon or bus, would you like to use it? (Yes or No) If so, then why?

1-2

8	Do you like to walk or use bicycle for short distance trip? e.g. going to nearby market or shop or park					
Specific to car/ motorcycle/ auto-rickshaw users						
9	If/when, you need to use public transport in some cases, then, which public transport mode or service would/do you prefer? (Daewoo bus, Lahore transport company bus, qingqi (motorcycle rickshaw)					
10	What do you think about the provision of these policies and what will be your response and intentions against them? a. Even and odd policy- use of car/ motorcycle on alternative weekdays based on even and odd last digit of registration number of vehicle b. Car/ motorcycle entry restrictions in public transport service area e.g. 2-3 km from high court or assembly hall					
Specific to car and auto-rickshaw users						
11	Let suppose the travel cost of car usage is increased in order to reduce traffic congestion and environmental problems by increasing parking charges, vehicle registration taxes, fuel taxes and road taxes. What do you think about these fiscal restrictions or disincentives on car use considering reduction in traffic congestion, travel time, air pollution and health cost? What will be your response and intention to these restrictions? Below improved transport mean, a transport with service quality as per demands of car users as mentioned in question 4.					
	a.	**Travel options**	**Overall travel cost**	100%	200%	300%	400%
		Continue to use car same as before					
		Sometimes by car and sometime by improved public transport					
		Totally prefer to travel by improved public transport					
	b.	**Travel options**	**Parking charges**	50 Rs.	75 Rs.	100 Rs.	150 Rs.
		Continue to use car same as before					
		Sometimes by car and sometime by improved public transport					
		Totally prefer to travel by improved public transport					
	c.	**Travel options**	**Road tax or toll**	50 Rs.	75 Rs.	100 Rs.	150 Rs.
		Continue to use car same as before					
		Sometimes by car and sometime by improved public transport					
		Totally prefer to travel by improved public transport					
	d.	**Travel options**	**Fuel taxes**	20 Rs.	30 Rs.	40 Rs.	50 Rs.
		Continue to use car same as before					
		Sometimes by car and sometime by improved public transport					
		Totally prefer to travel by improved public transport					
	e.	**Travel options**	**Registration taxes**	50 %	75 %	100 %	150 %
		Continue to use car same as before					
		Sometimes by car and sometime by improved public transport					
		Totally prefer to travel by improved public transport					
Specific to motorcycle and auto-rickshaw users						
12	Let suppose the travel cost of motorcycle usage is increased in order to reduce traffic congestion and environmental problems by increasing parking charges, vehicle registration taxes, and fuel taxes. What do you think about these fiscal restrictions considering reduction in traffic congestion, travel time, air pollution and health cost? What will be your response and intention to these restrictions? Below improved transport mean, a transport with service quality as per demands of motorcycle users as mentioned in question 4.					
	a.	**Travel options**	**Overall travel cost**	100%	200%	300%	400%
		Continue to use motorcycle same as before					
		Sometimes by motorcycle and sometime by improved public transport					
		Totally prefer to travel by improved public transport					
	b.	**Travel options**	**Parking charges**	20 Rs.	30 Rs.	40 Rs.	50 Rs.
		Continue to use motorcycle same as before					
		Sometimes by motorcycle and sometime by improved public transport					
		Totally prefer to travel by improved public transport					
	c.	**Travel options**	**Fuel taxes**	20 Rs.	30 Rs.	40 Rs.	50 Rs.
		Continue to use motorcycle same as before					
		Sometimes by motorcycle and sometime by improved public transport					
		Totally prefer to travel by improved public transport					

Appendix E: Preferred quality of service of public transport

	Car users		**Motorcycle users**		**Public transport users**	
Attributes	Desire level	Remarks	Desire level	Remarks	Desire level	Remarks
Walking time to/from bus stop	Max 5 min (6), max 10 min (5), max 15 min (3)	It is difficult to walk at 45 ^{0}C and in bad weather, but good for health	Max 5 min (8), max 10 min (5), max 15 min (2)	unsecure and unsafe to walk for female, depends on weather and season	Max 5 min (4), max 10 min (8), max 15 min (1)	Unsecure to walk for female, depends on weather and season
Transfer	Preferably no transfer and direct access is more desirable (One transfer is fine if it does not increase travel cost and time					
Waiting time	Max 5 min (3), 10 min (6) , 15 min (5)		Max 5 min (3), 10 min (11) , 15 min (1)		Max 5 min (4), 10 min (7), 15 min (2)	
Seat quality	Sofa seat	plastic seat is little fine	Sofa seat, one said teat type does not matter		Sofa seat	
Travel cost	Does not matter so much		Less than motorcycle travel cost and current public transport		less than current travel cost	
Sitting	comfortable standing for short trip, sitting for long trip, it is difficult to stand in public		100% sitting, sitting for elder people, sitting is somewhat important		Comfortable standing, without seat I do not travel	
Other important service attributes	Air-conditioning and heater (controlled temperature) A punctual and time saving service Schedule and stop should be fix Travel time should be fix Well educated and skilled crew Safe and secure Comfortable and no overcrowding Proper stoppage at stop for get in and get off Complete physical separation between male and female compartments Good interior facilities in vehicle Facilities for disable and elder people Dissemination of schedule and route information at bus stop Educated passengers "Different type of bus services for different class of people and different fare structure accordingly"		Air-conditioning and heater (controlled temperature) A service without issue of traffic jam (BRT or bus lanes) Electronic fare collection system Shortest route and number of route should be more Good condition of vehicle (outlook should be attractive) Well educated and skilled staff Time saving, punctual and reliable in travel time Seats should be comfortable and proper gap between seats No over-crowding Complete physical separation among male and female compartment Proper scheduling Dissemination of route and schedule information at bus stop Hygienic interior environment (internal pollution should be prohibited along with protection from outside pollution) 1 ticket system for one-way commuting trip which should be suitable for all type of modes Facilities for elder and disable people Entertainment facilities, and education of users (wear & tear of seats)		Air-conditioned and heater Good condition of vehicle Driver education and skills and good crew attitudes Reliable and time saving Hygienic interior environment Non-smoking and no-overcrowding Provision of emergency gates Separate routes for male and female Route should be shortest Facilities for elders and pregnant women Eating should be prohibited Safer environment Protection from rain and sunlight	
Willingness to use	Sometimes (9), almost every time (3), Every time (2)		Sometimes (8), almost every time (4), Every time (3)		Almost every time (11), Every time (2)	

Note: number in parenthesis indicate number of interviewees in each category, Max: maximum, Min: minutes

Appendix F: A typical output file of SEM model

Analysis Summary

Groups

Group number 1 (Group number 1)

Notes for Group (Group number 1)

The model is recursive.

Sample size = 354

Variable counts (Group number 1)

Number of variables in your model	78
Number of observed variables	29
Number of unobserved variables	49
Number of exogenous variables	39
Number of endogenous variables	39

Parameter summary (Group number 1)

	Weights	Co-variances	Variances	Means	Intercepts	Total
Fixed	49	0	0	0	0	49
Labelled	0	0	0	0	0	0
Unlabeled	38	0	39	0	0	77
Total	87	0	39	0	0	126

Models

Default model (Default model)

Notes for Model (Default model)

Computation of degrees of freedom (Default model)

Number of distinct sample moments	435
Number of distinct parameters to be estimated	77
Degrees of freedom (435 - 77)	358

Result (Default model)

Minimum was achieved

Chi-square = 774.378

Degrees of freedom = 358

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
AR	<---	AC	.487	.106	4.584	***	
PN	<---	AR	.543	.073	7.475	***	
PN	<---	AC	.155	.065	2.402	.016	
SN	<---	FF	-.467	.181	-2.574	.010	
SN	<---	SS	-.239	.086	-2.766	.006	

			Estimate	S.E.	C.R.	P	Label
Attitudes	<---	SN	.938	.086	10.974	***	
Attitudes	<---	SS	.206	.087	2.362	.018	
Attitudes	<---	PN	.262	.097	2.695	.007	
PBC	<---	FF	.180	.094	1.924	.054	
PBC	<---	SS	.106	.047	2.255	.024	
PBC	<---	Attitudes	-.068	.032	-2.145	.032	
Intention	<---	Attitudes	.128	.057	2.234	.025	
Intention	<---	Status	.444	.118	3.751	***	
Intention	<---	Civil	.416	.114	3.640	***	
Intention	<---	PN	.185	.091	2.041	.041	
Intention	<---	PBC	-.425	.232	-1.832	.067	
Intention	<---	FF	.678	.211	3.207	.001	
Intention	<---	HPI	-.658	.122	-5.398	***	
WTPT	<---	Intention	.491	.057	8.591	***	
WTPT	<---	PN	.458	.085	5.413	***	
WTPT	<---	Attitudes	-.108	.044	-2.455	.014	
WTPT	<---	FF	.397	.148	2.688	.007	
AC3	<---	AC	1.000				
AC2	<---	AC	1.209	.151	8.010	***	
AC1	<---	AC	1.366	.171	8.000	***	
AR3	<---	AR	1.000				
AR2	<---	AR	1.074	.074	14.590	***	
AR1	<---	AR	.601	.081	7.383	***	
PN3	<---	PN	1.000				
PN2	<---	PN	1.194	.143	8.325	***	
PN1	<---	PN	1.293	.153	8.472	***	
Q11	<---	PBC	1.000				
Q12	<---	PBC	2.263	.650	3.482	***	
Q13	<---	PBC	2.571	.766	3.356	***	
Q4	<---	FF	1.000				
Q5	<---	FF	1.072	.262	4.090	***	
Q7	<---	Attitudes	1.000				
Q8	<---	Attitudes	.910	.078	11.631	***	
Q14	<---	Attitudes	.416	.071	5.866	***	
Q6	<---	SS	1.000				
Q1	<---	SS	1.079	.302	3.570	***	
Q15	<---	FF	.948	.238	3.984	***	
OTU1	<---	Intention	1.012	.075	13.541	***	
OUT2	<---	Intention	1.000				
OTS1	<---	WTPT	.942	.060	15.596	***	
OTS2	<---	WTPT	1.000				
Q10	<---	SN	1.000				
Q9	<---	SN	1.236	.097	12.743	***	

Standardized Regression Weights: (Group number 1 - Default model)

			Estimate
AR	<---	AC	.344
PN	<---	AR	.748
PN	<---	AC	.151
SN	<---	FF	-.242
SN	<---	SS	-.223
Attitudes	<---	SN	.798
Attitudes	<---	SS	.164
Attitudes	<---	PN	.148
PBC	<---	FF	.241
PBC	<---	SS	.256
PBC	<---	Attitudes	-.205
Intention	<---	Attitudes	.152
Intention	<---	Status	.199
Intention	<---	Civil	.193
Intention	<---	PN	.124
Intention	<---	PBC	-.167
Intention	<---	FF	.356
Intention	<---	HPI	-.291
WTPT	<---	Intention	.534
WTPT	<---	PN	.333
WTPT	<---	Attitudes	-.139
WTPT	<---	FF	.227
AC3	<---	AC	.584
AC2	<---	AC	.692
AC1	<---	AC	.713
AR3	<---	AR	.824
AR2	<---	AR	.830
AR1	<---	AR	.416
PN3	<---	PN	.483
PN2	<---	PN	.758
PN1	<---	PN	.806
Q11	<---	PBC	.251
Q12	<---	PBC	.585
Q13	<---	PBC	.705
Q4	<---	FF	.520
Q5	<---	FF	.423
Q7	<---	Attitudes	.807
Q8	<---	Attitudes	.718
Q14	<---	Attitudes	.347
Q6	<---	SS	.632
Q1	<---	SS	.678
Q15	<---	FF	.396
OTU1	<---	Intention	.848
OUT2	<---	Intention	.814
OTS1	<---	WTPT	.832
OTS2	<---	WTPT	.906

			Estimate
Q10	<---	SN	.740
Q9	<---	SN	.899

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
e54	.480	.096	4.983	***	
e25	.311	.095	3.270	.001	
e29	1.009	.317	3.184	.001	
e44	.846	.103	8.177	***	
e12	1.031	.147	7.012	***	
e15	.172	.046	3.767	***	
e24	.594	.125	4.740	***	
e26	.141	.075	1.874	.061	
e48	.243	.018	13.285	***	
e49	.228	.017	13.285	***	
e51	.220	.017	13.285	***	
e37	.767	.112	6.866	***	
e43	.415	.062	6.666	***	
e1	.929	.088	10.513	***	
e2	.763	.094	8.096	***	
e3	.864	.115	7.509	***	
e4	.453	.060	7.523	***	
e5	.499	.068	7.301	***	
e6	1.664	.130	12.784	***	
e7	1.660	.133	12.455	***	
e8	.535	.057	9.389	***	
e9	.455	.057	7.960	***	
e16	2.578	.202	12.750	***	
e17	1.707	.224	7.635	***	
e18	1.159	.249	4.646	***	
e19	.838	.098	8.591	***	
e20	1.641	.155	10.556	***	
e21	.854	.124	6.894	***	
e22	1.245	.130	9.568	***	
e23	2.023	.157	12.850	***	
e27	1.517	.300	5.047	***	
e28	1.381	.340	4.064	***	
e30	1.500	.137	10.965	***	
e33	.450	.076	5.938	***	
e34	.575	.079	7.252	***	
e39	.377	.051	7.395	***	
e40	.209	.050	4.157	***	
e52	.953	.101	9.477	***	
e56	.418	.112	3.741	***	

Squared Multiple Correlations: (Group number 1 - Default model)

	Estimate
AC	.000
SS	.000
FF	.000
AR	.119
SN	.108
PN	.661
Attitudes	.628
HPI	.000
Status	.000
Civil	.000
PBC	.186
Intention	.320
WTPT	.565
Q9	.809
Q10	.548
OTS2	.820
OTS1	.692
OUT2	.662
OTU1	.720
Q15	.157
Q1	.460
Q6	.399
Q14	.120
Q8	.515
Q7	.652
Q5	.179
Q4	.271
Q13	.498
Q12	.343
Q11	.063
PN1	.650
PN2	.574
PN3	.234
AR1	.173
AR2	.689
AR3	.680
AC1	.509
AC2	.479
AC3	.341

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	77	774.378	358	.000	2.163

Model	NPAR	CMIN	DF	P	CMIN/DF
Saturated model	435	.000	0		
Independence model	29	3303.916	406	.000	8.138

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.138	.864	.834	.711
Saturated model	.000	1.000		
Independence model	.305	.519	.485	.485

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.766	.734	.859	.837	.856
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.882	.675	.755
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	416.378	339.943	500.551
Saturated model	.000	.000	.000
Independence model	2897.916	2718.348	3084.855

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.194	1.180	.963	1.418
Saturated model	.000	.000	.000	.000
Independence model	9.360	8.209	7.701	8.739

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.057	.052	.063	.015
Independence model	.142	.138	.147	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	928.378	942.682	1226.314	1303.314
Saturated model	870.000	950.805	2553.144	2988.144
Independence model	3361.916	3367.303	3474.125	3503.125

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	2.630	2.413	2.868	2.670
Saturated model	2.465	2.465	2.465	2.693
Independence model	9.524	9.015	10.053	9.539

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	184	193
Independence model	49	51