CARDIFF UNIVERSITY

Cardiff School of City and Regional Planning

Household Travel and Tour-Based Behaviour: A Case Study from Saudi Arabia

A thesis submitted to the Cardiff School of City and Regional Planning, Cardiff University in fulfilment of the requirement for the degree of

Doctor of Philosophy

BY

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In the Name of Allah, the Most Beneficent, the Most Merciful

Abstract

The present study utilises the activity-based approach to investigate the nature and determinants of travel behaviour, and to reach a better understanding of travel complexity within households in an Islamic cultural environment. The main objectives of this study are, firstly, to describe and explain the variation of behaviour between a sample of Saudi households and, secondly, to identify the likely response to specific transport policies.

Seven neighbourhoods in Dammam city were selected as case studies. Personally administered questionnaires, and in-depth interviews and a field inventory were employed to establish the study's database, and the GIS package (ArcView 3.2) was used to compute and analyse data obtained. Quantitative and qualitative approaches were adopted to accomplish the study objectives.

Poisson regression models used to estimate the trip generation rate of Saudi households suggest that household characteristics (income, number of employees, number of school children) and neighbourhood characteristics (density, accessibility to work) were significant variables influencing the trip rate per household.

Linked activities expressed as trip tours were used to describe travel behaviour. The multinomial logit (MNL) model was used to estimate the household head's work tour type. Results suggest that household head attributes (occupation, education and income), household socio-economic characteristics (car ownership, availability of a chauffeur, number of female students, number of females in employment, and household size), and neighbourhood characteristics (density, accessibility to work) significantly influenced the choice of work tour type. The usefulness of applying tour-based analysis and its strength in showing interactions between household members' activities were confirmed in this study. Tour-based models revealed that Saudi households' travel activities were highly dependent on the household head, who is mainly responsible for serving household members' travel needs.

In-depth interviews showed concerns about children's safety and security, lack of public and, in particular, school transport, ignorance of female travel needs, and car oriented neighbourhood design were main reasons for the high dependency on the car and its role as the dominant travel mode within Saudi cities. Interviewees were presented with five transport related policies to investigate their likely impact on households' travel behaviour. Interviewees agreed that the proposed policies would decrease car dependency and increase the travel independence of household members.

Change in travel behaviour, in response to proposed policies, as identified by interviewees included decreased travel complexity (simpler tours), change in tour mode (more walking and public transport tours), and change in tour time. The study estimated a reduction in car trips generated by households as a result of introducing policies aimed to shift dependent groups (i.e. children and females) towards independence through walking and use of public transport.

Dedication

To my father and my mother

for their supplication, support, sacrifice, and encouragement

throughout my life.

Acknowledgment

First of all, my deepest appreciation to, ALLAH, for giving me and my family good health and spiritual support, emotional and physical strength, to go through this journey of life.

This work would not have been completed without the great support and sincere help from many people. First of all, I would like to thank my supervisors Professor Huw Williams and Dr. Martyn Senior for their support, invaluable suggestions, and patient guidance throughout the course of this study, which have contributed to its successful completion.

My thanks also go to the staff of the Cardiff School of City and Regional Planning, particularly to Professor Chris Webster for his continuous encouragement throughout the course, and also to Mr. Andrew Edward and Mr. Tom Garne for their IT support.

I would like to extend my appreciation to King Faisal University for providing me with a generous scholarship to complete my PhD. My thanks are extended to the Chairman and staff of Urban and Regional Planning Department in KFU for their support during my study. Thanks are also due to the Saudi Arabian Cultural Attaché in London and to his staff for their constant help and cooperation.

I wish to express my gratitude to my five students, of whom I am proud, for voluntarily participate in the distribution of questionnaires: Eng. Awad Al-Dayoufi, Mr. Saleh Al-Atawi, Eng. Dayeb Al-Atawi, Mr. Sultan Al-Balawi, and Mr. Ayed Al-Atawi. I am also grateful to those household heads who took part in the questionnaire survey and interviews for giving so generously of their time and for their hospitality.

I would like to express my thanks to my brothers Ahmed and Salem for their support to me and my family during my stay in the UK.

Ultimately, this study would not have been possible and concluded without the sacrifice, patience, encouragement, and endless help throughout this research from my family.

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CHAPTER ONE

Introduction

1.1 Background

There is a continuing trend of increasing reliance on the car as a travel mode. The car has become the favourite choice of travellers for several reasons: first, cities have experienced huge growth in terms of area, which increases distance to destinations within them; second, many newly developed areas are often low density and have historically been poorly served by public transport in comparison to high density areas; and, third, the car's attractiveness as a convenient and reliable travel mode. However, the increase in car use has been at the expense of public transport; in Britain, for example, users of public transport fell by 27% between 1975 and 1993 (Pharoah, 1996). Moreover, increase in car use has environmental, social and economic effects. As can be seen from Table 1.1, Newman and Kenworthy (1996) listed several costs of car dependency in cities. Due to high dependency on cars in Saudi Arabia most of these factors apply to Saudi cities. Environmental costs include human problems resulting from breathing in air pollutants from gases produced by transport modes, mainly the car. Increased car use leads to an increase in the number of accidents, congestion, and high infrastructure costs. Increase in car use has a social implication such as loss of community and loss of human scale of cities. These impacts apply in both developed and developing countries. However, developing countries appear to face more serious challenges resulting from car-related traffic

accidents, nearly 1 million people per year are killed in road accidents, about 85% occur in developing and transitional economy countries (Gwilliam, 2003).

Table 1. 1 Problems resulting from car dependency

Environmental	Economic	Social
1.Oil vulnerability 2.Photochemical smog 3.Lead, benzene pollutants 4.High greenhouse gas contributions 5.Urban sprawl 6.Greater storm water problems from extra hard surface 7.Traffic problems- noise	1. External costs from accidents, pollution, health impacts 2. Congestion costs, despite endless road building 3. High infrastructure costs in new sprawling suburbs 4. Loss of time due to sprawl, increasing distances	1. Loss of street life 2. Loss of community 3. Loss of public safety 4. Access problems for the carless and those with disabilities

Source: Adopted from Newman and Kenworthy, 1996, p. 6.

Islamic cities have experienced the same phenomena associated with the growth in car use. Old Islamic cities were built on a human scale, with the mosque at the centre of the community. Streets were designed to accommodate pedestrians and camels for the carriage of goods. However, today, Islamic cities are packed with cars and have lost their identity due to imported neighbourhood designs, for example, the grid iron system (Al-Fouzan, 1995).

In this study, Saudi Arabia (SA) has been selected to represent the Islamic environment for several reasons. First, Saudi Arabia is important in the Islamic world, since it is the land where the prophet Mohammed (Peace be upon him) started his call for Islam, it contains two holy mosques in Makkah and Madina, and all Muslims are requested to perform pilgrimage to Makkah. Second, Islamic regulation is the main resource for legislation in SA and Islamic regulation is highly respected and obeyed by Saudis; and, third, SA is a good example of harmony between Islamic communities living in modernised neighbourhoods, and communities which have been influenced by Western planning styles.

During the last four decades, Saudi communities have faced remarkable changes in their built environment. In the late 1960s and early 1970s, before oil explorations, people lived in compact traditional towns where they were able to access their needs on foot (e.g. mosque, market, and social visits); and built areas were supportive to walking (Al-Fouzan, 1995). During the economic boom in the country, between the early 1970s and mid 1980s, resulting in an increase in oil revenues, the Saudi government used these revenues to construct the infrastructure for Saudi cities to accommodate the rapid growth in urbanisation as a result of internal (from rural areas) and external (from abroad) immigration to the main cities which formed growth centres. Increased demand for housing in growth centres necessitated adequate land supply provision to accommodate the increase in the urban population. This, in turn, led to rapid urban growth as the development of vacant land outside old cities continued. Some cities increased over ten times in area during the period of the economic boom (Al-Fouzan, 1995).

Ongoing urban development in Saudi cities led to change in the structure of urban form. Accessibility to the city centre, market, workplace, etc., necessitated car ownership as distance between destinations increased. Moreover, the economic boom allowed ordinary Saudis to possess their own car and the car subsequently became the dominant mode of travel since public transport was unreliable and destinations became too difficult to access on foot. Car popularity continued to increase due to the government's failure to introduce methods of car restraint, such as taxation, fuel price, and parking tariffs. For these reasons, Saudi households came to increasingly depend on the car to perform their travel activities.

The identity of Saudi cities is not only formed by the pattern of urban growth but also by prevailing Islamic teaching. At the heart of each Islamic neighbourhood is

the mosque. All adult male Muslims have to pray at the mosque five times during day and night, thus the mosque is a key destination for all adult males. Islamic culture also influences the household size. Muslims do not believe in birth control, so Saudi households average 7.7 persons per household (Arriyadh Development Authority (ADA),1998).

Saudi Arabia also applies complete segregation between male and female based on Islamic regulation. For this reason, the Saudi educational system has separate educational institutions for boys and girls. Boys and girls attend separate schools which leads to an increase in the number of household trips performed to drop off/pick up children at/from school. Further, the Saudi authority forbids women to drive cars based on Islamic regulation. This situation has no effect in old compact cities where women can fulfil their needs by walking, but, nowadays, with the increased dependency on the car to access destinations, female members of a household have to rely on male members to give them lifts. This unique situation of the Saudi female makes the interdependency between household members' travel activity more complex. The inability of women to drive has been one of the main reasons for the existence of chauffeurs in Saudi households. Chauffeurs are recruited to assist in performing the travel activities within households.

From the above, it can be seen that Saudis have special cultural factors which require sensitive selection of travel modes. Saudi cities are also facing a problematic situation as a result of extensive car use due to high dependency on it as a travel mode assisted by the economic situation which makes cars easily affordable, absence of public transport modes, lack of deterrents to car use, and the rapid growth of urban development in Saudi cities.

As a result of the negative impacts of car use, such as congestion, noise, and air pollution in Saudi cities, attention first turned to building mass road network infrastructures to solve existing traffic problems. However, because such policies failed to achieve their intended aims in decreasing the cost of travel (economic and environmental costs), more recent policies in the transportation field aim to reduce car use through traffic demand management, introducing public transport modes and encouragement of walking, have received the attention of transportation planners in Saudi cities in the last decade. For example Riyadh, the capital, is running a pilot project for public transport (a light rail system) (ADA, 2004). Thus, transportation planners in Saudi cities in the last decade have shifted their policies from building new roads to travel demand management policies. To be effective, a detailed understanding of travel behaviour and response to transport policies is required, both in a general and in specific local contexts. This study aims to contribute to this understanding.

1.2 Research Motivation

The present research focuses on the travel behaviour of Islamic communities, using Saudi households as an example, with the aim of exploring the nature of their travel activities, factors influencing travel decision, and the impact of change in transportation related policies on household travel decisions.

The primary objective of travel behaviour research is to provide an understanding of how and why people travel, to define the factors influencing their travel decision, and to provide information to evaluate alternative transportation policies by predicting the implications of alternative policies (Fisher,1987).

This study takes into account the above definition to investigate travellers' behaviour in an Islamic environment. Cultural factors have been tested in previous

work in the travel behaviour literature in terms of family structure, urban versus rural residents, and comparison between countries. Although many studies have applied comparisons between cities around the world (Newman and Kenworthy, 1999; Schwanen, 2002; Timmermans et al., 2003), no detailed account has been taken of the influence of cultural influences such as religion, social customs, and traditions.

The current research focuses on the cultural environment and its impact on travel behaviour in an Islamic society, which present an excellent opportunity to investigate in-depth the importance of the cultural environment in travel behaviour. Islamic regulations influence every aspect of a Muslim's day-to-day activities (for example, travel to the mosque, segregation between females and males in the work place and educational facilities, the size of the Muslim family). All the aforementioned cultural and environmental influences will inevitably affect the travel decisions of Saudis. A study of Saudi households will thus provide an interesting insight into travel behaviour in an Islamic environment.

For the purpose of infrastructure development, the government has invested considerable capital in developing projects related to infrastructure building. Available studies of these can be classified into three groups:

Traffic sections in city Master Plan reports: data included in these studies cover the road network, O-D surveys, traffic counts, signal timing and management (Arcepaln, 1994). These studies are requested by the Ministry of Municipality and Rural Affairs (MOMRA).

Feasibility studies for mass transport services in major cities: these aims to evaluate the efficiency of existing public transport modes and develop a model for travel demand forecasts in the plan years. These studies have been prepared for the Ministry of Transport, formerly called the Ministry of Communication.

Research oriented studies: these studies examine the travel pattern of certain groups. For example, Almetair (1988) studied the influence of socio-economic factors on female teachers' transport mode choices to work. Zazoe (1996) examined female teachers' trips to work. She analysed work trip characteristics: travel mode, travel distance, travel time, and travel cost. Al-Qabbani (1998) studied work trips in Riyadh city, in terms of distance, travel mode, travel time, and worker characteristics. Al-Zaharani (2002) investigated the attitudes and preference of Saudi families towards school transport in Saudi Arabia. He developed a modal split model for students based on the existing modes used to transport them to and from schools. Al-Kharayef et al. (1994) studied factors influencing students' travel modes to and from school.

However, there is very little prior work analysing the travel behaviour of Saudi households, in particular their travel pattern, travel decision, and constraints related to travel activities. Extant studies look at specific group needs for a single travel purpose. Thus, none of the previous work has looked at household travel decisions and their interactions, how household characteristics influence travel decisions, nor how land use affects travel behaviour. In contrast, the present study intends to cover all travel activities for all household members for all purposes. In addition, no previous work in the Saudi literature on travel behaviour has examined the structure of journeys, which is another focus of this research.

Travel behaviour is concerned with predicting travellers' response to policy changes. Because of an increase and change in travel activity and the negative impact of Saudi cities' high rate of car ownership on residents' quality of life, overuse of the car has led to the development of Travel Demand Management (TDM) policy measures aimed at reducing car dependency. The efficiency and success of such policies largely depends on how people will respond to them.

1.3 Aim, objectives, and working hypothesis

This study aims to explore the nature and determinants of travel behaviour and reach a better understanding of the travel complexity of households in an Islamic cultural environment. To attain this aim, the study has the following specific research objectives:

1- To characterise the travel behaviour of Saudi households; to explain and understand travel variation between households, and to identify its determinants with particular reference to cultural factors.

2- To identify the likely response to specific transport policies.

A working hypothesis is that travel behaviour, through activity participation, will be influenced by: the characteristics of households, the transportation system, and neighbourhood characteristics, and the cultural environment will be an important determinant for understanding the journey structure for various activities.

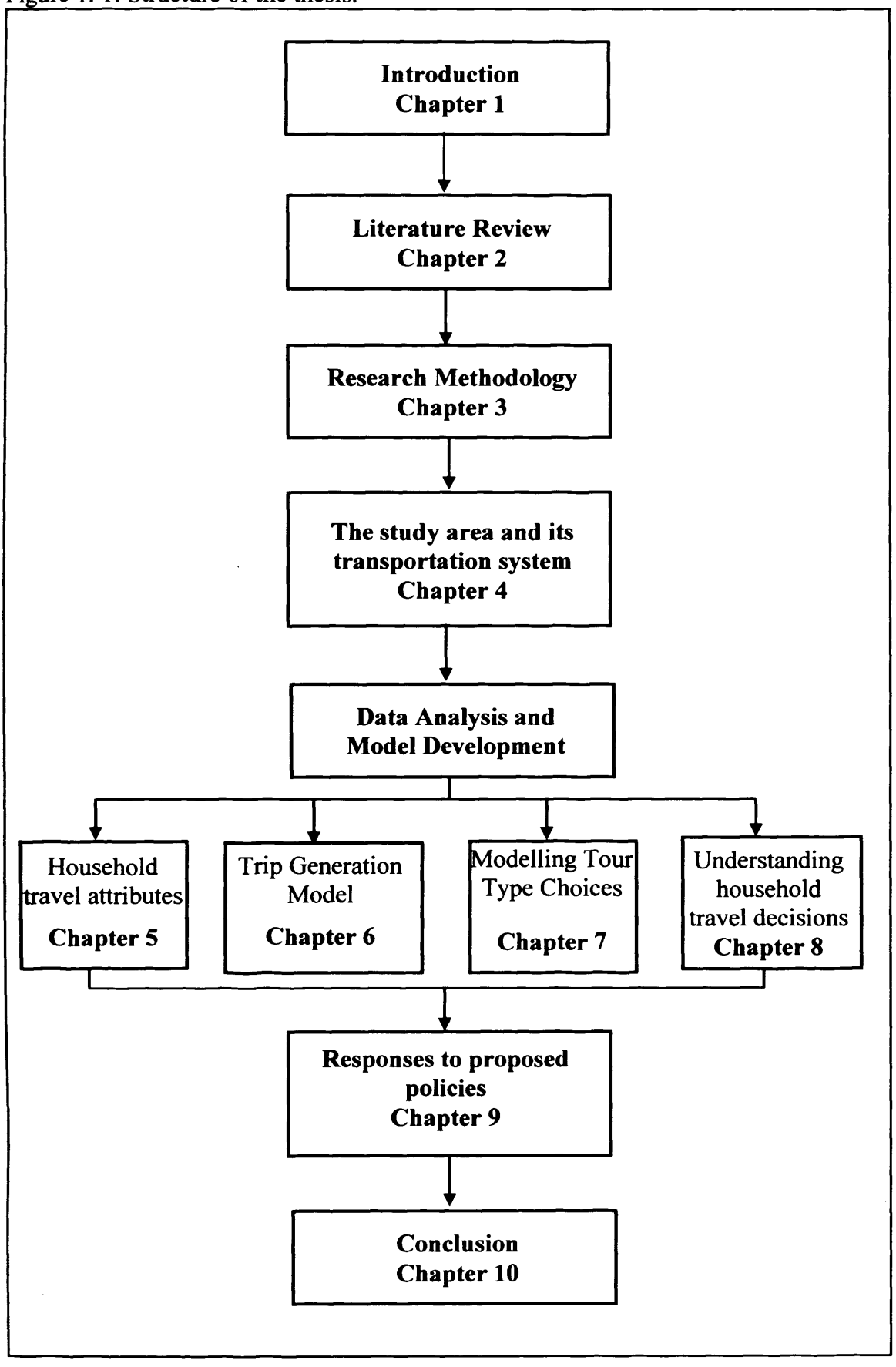
1.4 Research approach

To achieve the study objectives, the study will apply both quantitative and qualitative analysis techniques. The former will include the discrete choice approach and regression models of trip generation. The latter will employ in-depth interviews to explore possible behavioural changes of travellers in the household in response to changes in transport-related policies.

1.5 The structure of the thesis

The thesis comprises ten chapters (see Figure 1.1). Chapter one provides an introduction to the research. Chapter two undertakes a literature review related to travel behaviour: it focuses on modelling, theoretical development, and policy analysis.

Figure 1. 1: Structure of the thesis.



Chapter three describes the details of the research methodology. It discusses the conceptual and theoretical base of this research, and specifies the models used and the data required for these models. The survey design, its implementation, and the process of building the database for the research are also detailed.

Chapter four discusses the study area selected, providing background details of Dammam city, where the empirical work will take place, and gives a general picture of urban transportation in Dammam. Also, this chapter describes the characteristics of selected neighbourhoods.

Chapter five presents the results of the descriptive analysis of households' travel behaviour. It provides an introductory explanation of the effect of household characteristics on travel behaviour and explains the variation in travel behaviour over different neighbourhoods. Chapter six examines the factors influencing household trip generation by car. It discusses the results of a trip generation model for Saudi household models using Poisson Regression.

Chapter seven provides a detailed study of the structure of work journeys. It discusses the specification of a multinomial logit model to establish the association between selection of work tour type, which links activity, and household characteristics and land use. In chapter eight a more detailed behavioural analysis of travel decisions is undertaken and the constraints and opportunities facing households' in making such decisions are specifically discussed. This chapter details the results of semi-structured interviews with household heads.

Chapter nine presents households' stated behavioural changes in response to proposed policies. It illustrates the implications of the proposed policies for existing travel behaviour. Finally, chapter ten presents the study conclusions, its contribution, and some limitations of the research.

CHAPTER TWO

Literature Review

2.1 Introduction

In this chapter, the extensive literature on travel behaviour and factors influencing household travel decisions relevant to the aims of this research is reviewed. The theoretical bases of and empirical evidence relating to the development of travel behaviour models are examined. Travel behaviour modelling development is discussed in section 2.2, and the various theoretical approaches to model development are also investigated. After the initial overview of the theoretical base of travel behaviour literature, a review of trip generation models follows in section 2.3, since these models are ideal examples of the use of aggregated and disaggregated approaches and will form part of the current research.

Activity-based travel analysis has become the focus of much of the travel behaviour literature in the last two decades. This is because activity-based travel behaviour models make it possible to link travel activities performed within the same journey (i.e. tour-based models). Journey structure and development of the tour-based approach will therefore be discussed in section 2.4. Empirical evidence of trip chaining and attempts to produce operational models for activity-based travel behaviour will also be reviewed.

The inter-relationship between urban form, land use, and transport is briefly reviewed, in section 2.5, in order to analyse the link between household travel decision and its local environment. Different approaches to conduct policy-related analyses are

then presented in section 2.6. Both quantitative and qualitative approaches are analysed in order to explain the selection of the appropriate approach to be implemented in this research. A final section identifies several research gaps which have provided the motivation for the present study.

In this chapter, the research outlines the development in travel demand modelling approaches in order to select the most appropriate to be applied in this study. An aggregate model refers to analyses at the zone, neighbourhood or city level, whereas a disaggregate approach refers to analyses at the individual or household level (Handy,1996). A large segment of the research on travel behaviour falls into the category of aggregate analyses. As will be shown later in this chapter, disaggregate models may be more efficient than conventional models in terms of information usage.

Due to the nature of transport policies considered by this research, the study utilised the disaggregate approach. This chapter will provide a brief description of disaggregate models and their usage in travel behaviour studies focusing on trip generation rate (trip rate per household) and work tour type (using a tour-based model for the household head)

Predicting the response to change in transport-related policies is important due to the necessity to analyse the impact of transportation-related policies on households' travel behaviour. The high growth in car dependency has led to the need to develop new transportation policies, which necessitate research to evaluate the impact of change in policies on travel behaviour. The next section will accordingly review travel behaviour modelling using several theoretical approaches.

2.2 Perspective on travel behaviour modelling: an Overview

This section provides a brief background to the development of travel behaviour modelling, detailing different theoretical approaches which have contributed to development of this field, and forms the basis for discussion in following sections.

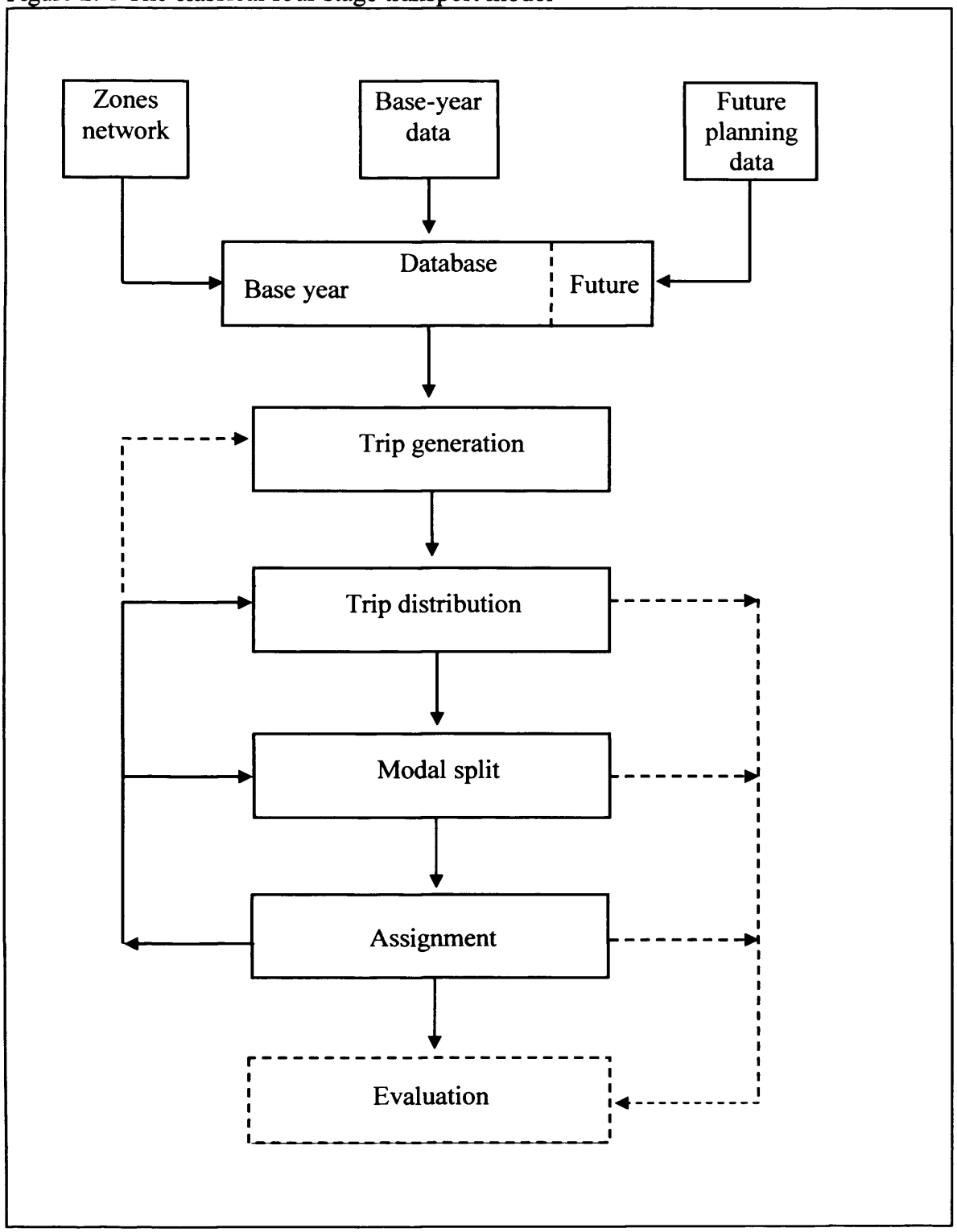
2.2.1 The classical four stage model

Many of the available travel demand forecasting models are based on the classical four stage model, which was developed in the 1950s and 1960s during the post-war expansion period, when there was high transportation infrastructure demand due to rapid urbanisation, increase in car use, and the beginning of urban sprawl (RDC Inc.,1995).

Since that time, the classical four stage transport model has been widely applied in the United States, the United Kingdom, and around the world. This strategic transport analysis model is shown in Figure 2.1, and in general form has changed little since the 1970s. The approach starts by dividing the study area into zones. A database is built for each zone and contains details of population and land use. The data are then used to estimate a model of trip generation for each zone. The next stage involves the distribution of trips according to the pattern of destination (e.g. origin and destination matrix). The subsequent step involves modelling the share of trips by each mode (modal choice). The last stage allocates trips to routes in the modal networks.

This four stage procedure makes urban travel demand forecasting relatively straightforward, using standard survey tools. However, it has long been argued that the four stage procedure has several weaknesses. Although the model was suitable in a period of infrastructure building, planning policies have changed substantially since then. Policies such as transportation systems management and travel demand management have become popular among transport planners and engineers. However, due to data inefficiencies, lack of a strong theoretical base, and behavioural foundation,

Figure 2. 1 The classical four stage transport model



Source: Ortuzar and Willumsen, 2001.

the four-step procedure could not be used adequately to evaluate these policies. The RDC Inc. (1995) summary of the limitations of the four-step model in current policy contexts is presented in Table 2.1. The main limitations relate to the model's specification, and the lack of a sound theoretical base.

Despite the shortcomings of this model, nearly 50 years after its development, it is still used widely as a popular travel forecast procedure (Boyce and Williams, 2003), probably because of its widespread applicability and practitioners' confidence in it as a useful tool in travel forecast and transportation planning. However, on account of the limitations of the four-stage model cited above, transportation planners have begun to consider the micro-econometric approach as a way of overcoming some of the limitations of the four-stage model, which will be discussed in the following section.

Table 2. 1 Limitations of the four-step model in current policy contexts

- Trip-based sequential structure
- Lack of the time-of-day dimension
- Limited sets of explanatory variables
- Limited behavioural responses
- Trip generation unresponsiveness to congestion and pricing
- The trip distribution phase is not fully responsive to system change
- Only exogenous land-use economic and socio-demographic input.

Source: RDC Inc, 1995.

2.2.2 The micro-econometric approach

A major innovation in the analysis of transportation demand forecasting has been the development of disaggregate travel demand models based on discrete choice analysis (Ben-Akiva and Lerman, 1985). By the late 1970s, the micro-econometric theory of discrete choice had taken root and was beginning to provide a behavioural basis for travel forecasting (Ben-Akiva and Lerman, 1985; Ortuzar and Willumsen,

2001; and McFadden, 2001). Discrete choice models may be underpinned by the theory of random utility maximisation where a decision maker is modelled as selecting the alternative with the highest utility among a possible set of alternatives at the time a choice is made. Most discrete choice models attempt to develop policy-sensitive models for predicting the market shares of alternative travel modes. Disaggregated behavioural demand models have been used for the past three decades and their underlying theory has received support from many, according to McFadden (2001) who stated:

> *"I believe that it has shown itself to be capable of addressing a broad array of policy questions within a modelling framework that has generally promoted sensible models and helped avoid blind alleys."*

Among discrete choices models, the most widely used models in the last 30 years have been the multinomial logit (MNL) and hierarchical or nested logit (NL). The MNL model is the simplest and most commonly used practical discrete choice model. The MNL has been widely and successfully applied in a large number of studies in the field of transportation planning. It has been used in mode choice, location choice, route choice, and time of day choice, and in many other applications in transport, economics, and market research (McFadden, 1974; Demenich and McFadden, 1975; Hensher, 1979; Anans, 1982; Ben-Akiva and Lerman, 1985; McFadden and Train, 2000; McFadden, 2001; Hensher and Brewer, 2001; Boyce and Williams, 2003). The popularity of the MNL model is due to its simple mathematical structure, the potential to add new alternatives, its ease of estimation, and the wide availability of estimation software (Badabaan, 2001).

The nested logit (NL) model is an extension of the simple multinomial logit, and allows error covariance and different competitiveness between pairs of alternatives (Williams, 1977; Daly and Zachary, 1979; Ben-Akiva and Lerman, 1979; McFadden, 1981; Koppelman and Wen, 1998; Carrasco and Ortuzar, 2002). For development of the

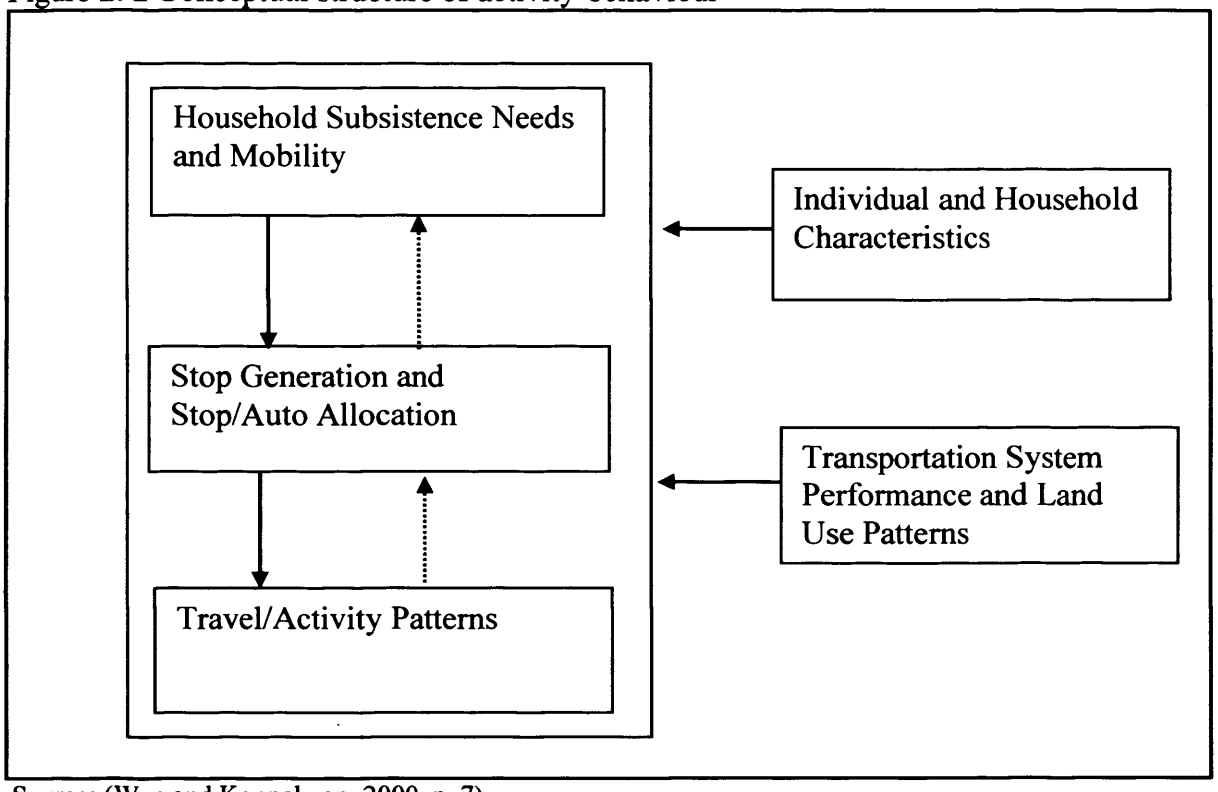
NL model specification, see for example, McFadden (2001). The NL model has been successfully applied in many studies in the transportation field, particularly for modal and location-mode combination (see, for example, Boyce and Williams, 2003, for a recent review).

The micro-econometric approach has made a very significant contribution to the transportation field, since it facilitates consideration of the variability in individual behaviour, provides an efficient sampling procedure for model estimation, and is founded on a suitable and stable theoretical perspective of individual behaviour (Boyce and Williams, 2003). Development of disaggregated models in the 1960s and 1970s provided the basis of the next generation of travel behaviour modelling (i.e. the activity-based approach) which sought a more sophisticated understanding of the decision context within which activity and travel choices are made.

2.2.3 Activity-Based Approach

The activity-based travel analysis approach received attention from the late 1970s as a potential replacement to the trip-based analysis approach (four stage model) because of its capability to account for activity participation demand, interrelationships among trips, and interaction between household members (Wen and Kopplman, 2000; Jones et al., 1983). According to Bowman and Ben-Akiva (2000), the most important elements of activity-based travel theory can be summarised under two assumptions: first, the demand for travel is derived from the demand for activities, and, second, humans face temporal-spatial constraints when they make their travel decisions. Travel behaviour in the activity-based approach is viewed as a link in the process of fulfilling individuals' needs through the formation and accomplishment of daily activities. Wen and Koppelman (2000) have proposed a conceptual structure of activity-based behaviour which comprises three main blocks, as shown in Figure 2.2. The first block

Figure 2. 2 Conceptual structure of activity-behaviour



Source: (Wen and Koppelman, 2000, p. 7)

relates to household subsistence needs and mobility decisions, which are long-run in nature. The second and third blocks include a set of short-run decisions. The second block consists of the generation of maintenance activities (stops), which fulfil the individual needs of each member of the household, and stops/auto allocations among household members exclusively or jointly. The final block illustrates individual daily travel/activity patterns through the generation of tours, the assignment of stops to tours, and the selection of locations for each stop and travel mode(s) for tours.

The decision components in the three blocks are influenced by a full range of exogenous variables, including individual and household characteristics (e.g. lifestyle and lifecycle), transportation system performance, and land use patterns (Wen and Koppelman, 2000). Activity-behaviour analyses have led to more use of household role, work schedule, and lifecycle stage variables in travel behaviour modelling.

Development of the activity-based travel approach has changed travel behaviour modelling on account of emphasising certain aspects, such as constraints governing activity engagement, behavioural change, the time dimension, day to day variability, scheduling of activities and trips over time, trip chaining, in home/out of home activity substitution, inter-personal linkages, and household life-cycle stages.

Section 2.2.3 presents the theoretical background to the activity- based approach; further discussion on activity-based modelling approaches will follow in Section 2.4. Before considering the development of operational activity-travel models further, trip generation models, which embrace a simplified form of trip-based analyses, are examined.

2.3 Trip Generation

The previous section has provided an overview of several theoretical approaches developed to investigate travel behaviour. This section provides a more detailed review of the trip generation literature, presenting comparisons between aggregated and disaggregated approaches. A trip, in this study, is defined as a "one way travel from one place (address) to another by any means of transportation" (Strathman and Dueker, 1995). A trip generation model will be used later in this research to identify factors influencing car trip rate in households.

2.3.1 From zonal-based model to household regression model

The first stage in the classical 'four-step' travel demand modelling procedure is that of trip generation, i.e. predicting the total number of trips that will be generated in each zone of the study area. Trip generation is a key stage in the forecasting of travel demand. Conventionally, in travel demand analysis, there are two types of trip: home based trips and non-home based trips. By definition, a home based trip has one end at

home, whereas a non-home based trip starts and ends at other locations (e.g. a midday trip from the workplace to a restaurant is considered a non-home based trip)

Classical methods of analysing trip generation include category analysis and zonal or household regression (Daly,1997). In the 1950s and 1960s, in linear regression models, the zone was taken as the unit of analysis strongly favoured to guide trip generation. Zonal based models were used in an attempt to find the (linear) relationship between the number of trips produced within a zone and the average socio-economic characteristics of households in each zone. However, this approach was criticised due to its limitation of only explaining the variation in trip making between zones. Further, the model output was conditioned by the nature and size of the zone. As a result, at the end of the 1960s, household-based regression models of trip production were developed, in which the dependent variable became average daily trips per household and was expressed as a function of the attributes of the household (Wootton and Pick, 1967; FHWA, 1967; Stopher and McDonald, 1983).

An alternative method of modelling trip generation appeared at the end of the 1960s. This method was known in the United States as cross-classification, and in the United Kingdom as category analysis. It underwent the same development phases as linear-regression models, with the earliest procedures utilising zonal trip estimators and subsequent models being based on household rates (Wootton and Pick, 1967; FHWA, 1967; Douglas and Lewis, 1971)

Ortuzar and Willumsen (2001) have identified the factors affecting trip generation as: income, car ownership, household structure, family size, value of land, residential density, and accessibility. The first four factors (income, car ownership, household structure, and family size) have been considered in several household trip generation studies, while value of land and residential density are typical of zonal

studies. The last one, accessibility, has rarely been used, although most studies have recognised that it may be important (Mansfield, 1969; Domencich and McFadeden, 1975; Department of Transport, 1997; Daly, 1997; Ortuzar and Willumsen, 2001), because it offers a way to make trip generation elastic (responsive) to changes in the transport system.

Care, however, is needed when there are variables in the model of a qualitative nature, and which show non-linear behaviour (e.g. occupation of the household head, gender, and housing ownership). Ortuzar and Willumsen (2001) identified two methods to incorporate non-linear variables into the model. One is to transform the variables in order to linearise their effect (e.g. take logarithms, raise to a power); whilst the other is to use dummy variables. In this case, the independent variable under consideration is divided into several discrete intervals each of which is treated separately in the model. In this form, it is not necessary to assume that the variable has a linear effect, because each of its portions is considered separately in terms of its effect on travel behaviour.

Trip generation models have been developed in two ways; first, by attempting to improve analysis of variance and, second, by looking for trip rate stability between appropriate household and individual groupings. The latter has been the real force guiding development of disaggregate models.

Empirical evidence of factors influence in trip rate are consider a little further because of its relevance to the research reported later.

2.3.2 Factors influencing trip generation: empirical evidence

A review of previous variables used to estimate trip rate is crucial at this stage in order to decide on variables for use in this study. Car ownership, income and household composition are relevant independent variables to utilise in trip generation models. In regression models, the household structure variable usually includes the number of adult

males, adult females, number of employees, household size, presence of children under school age, children attending school, etc. In typical category analysis models, household composition is presented as a category combining household size with employment status (Wootton and Pick, 1967). As a result of interest in the early 1980s in the activity-based travel approach, researchers introduced behavioural considerations into the trip generation equation by identifying a set of household types to reflect household "lifecycle" (Jones et al., 1983; Ortuzar and Willumsen 2001).

Accessibility, which measures the ease or difficulty of making trips to/from each zone, had tended to be neglected by classical four-stage models (Ortuzar and Willumsen, 2001). Daly (1997) consequently proposed a three-component framework for trip generation incorporating accessibility. An employment index, expressing the total number of jobs, is a popular proxy for accessibility at the aggregate zonal level. Further, variables such as access to a car, access to public transport (e.g. distance to bus stop), and distance to the Central Business Discrete (CBD) have also been used in regression models to estimate the impact of accessibility on analysing the impact of urban form on travel behaviour (Handy et al., 1998; Kitamura et al., 1997; Handy 1996; Cervero, 1996; Cervero and Gorham 1995; Holtzclaw, 1994).

Travel to school is a major traffic generator. In the past two decades, there has been a marked increase in car use for children's travel, in particular for school journeys. For example, in the UK, in the last decade, the proportion of journeys to schools by car had nearly doubled, to 29% from 16%, over the previous decade (Morris et al., 2001). In Australia, the major mode of travel by children of all ages is as a car passenger. The importance of school travel as a generator of car trips is due to a number of reasons: first, school journeys usually take place at peak times and have the same destination every day and, secondly, school escort trips account for a large proportion of travel by

households. In Melbourne, for example, in the morning peak period between 8.30 and 9 am, trips accompanying children to schools constitute 21% of the total trips made by people, and 84% of these are made by car.

Morris et al. (2001) identified two key factors influencing increased car travel by children. The first of these is parents' concern about their children's traffic safety and personal security. In a study conducted in 1992-93, 80% of parents referred to fearing for their children's safety as a result of having to cross roads at a time of high traffic volumes, while between 60% and 75% reported fear of their children being attacked on the street (Morris and Richardson, 1996). A second key factor is the increasing distances children have to travel to reach their school. For example, the average length of the journey to school had increased, in the UK, for children aged 5-10 by 18%, from 1.75 km in 1985/86 to 2.1 km in 1995/97, and for children aged 11-16 by 35%, from 3.65 km to 4.95 km, in the same period. Part of the reason for increasing travel distances is the increasing dispersion of facilities, caused by continuing urban sprawl. In the study by Godfrey et al. (1998), distance to school was the second most frequently factor cited by parents for driving their children to school on a regular basis. If students lived more than 1.5 miles (2.4 km) away from the school, it was very unlikely they would walk to school. Thus, it is not surprising that the proportion of chauffeuring trips has increased substantially as a result of longer travel distances to schools. Tranter (1995) has argued that the provision of a denser network of local facilities, such as schools, shops and recreational facilities, is crucial for creating an environment that is friendly to children.

The Poisson regression model has been applied as a method to analyse cross sectional data related to trip generation. Rickard (1988) produced a model to explain the variation in trip rate between individuals according to their personal characteristics and

geographical location. She applied a Poisson regression technique to explain inter-urban rail trip rates in terms of the socio-economic and demographic characteristics of an area.

After reviewing trip generation models, which provide ideal examples of trip based modelling, further discussion on the treatment of travel activity as linked activity (i.e. the tour based model) and its application is presented below.

2.4 Activity-based travel behaviour: the structure of the journey

Having reviewed trip generation in some depth, the researcher returns to consider the structure of the journeys themselves based on the activity approach introduced in section 2.2.3. Following the approach's development as a tool to investigate the travel behaviour of households, it has its own operational models which will be investigated in detail in the following sections.

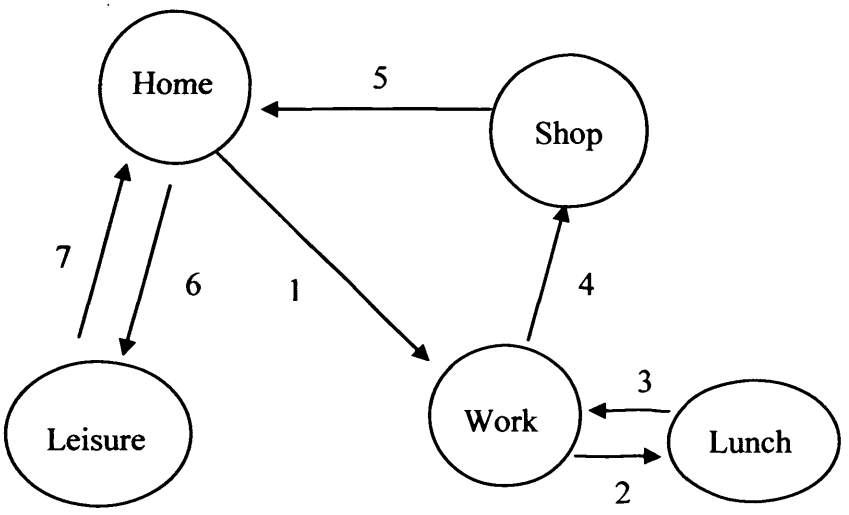
2.4.1 From trips to tours

Activity-based models analyse travel in the context of daily household activity patterns, as links in the process of fulfilling household needs through the formation of daily sets, or chains, of activities (Fox, 1995). The activity-based travel analysis approach focuses on the sequence or patterns of activity behaviour, with the whole day or longer periods of times as the unit of analysis. Activity and travel demand is viewed in terms of a choice among all possible combinations of activity and travel in the course of a day. This approach overcomes the drawback of trip based models which ignore the time and interdependency contexts in which travel decisions are made. Many authors have reviewed the shortcomings of trip-based models (Kitamura, 1988; Jones et al., 1990; Axhausen and Garling, 1992; RDC, 1995; and Kurani and Kitamura, 1996) and particularly their failure to relate travel behaviour to activity decisions. According to Krizek (2003b), trip-based analysis suffers from two basic problems: first, it considers each type of trip in isolation; and, second, it does not provide a tool to account for travel

combining multiple purposes. Before proceeding further, therefore, it is necessary to examine how the terms "trip" and "tour" are defined and classified

A tour is defined most often in the literature as a sequence of trip segments that start at home and end at home and analysed by looking at the number of trips or stops in the tour (Ben-Akiva et al., 1998; Bowman and Ben-Akiva, 2000; Bradely et al., 1999; Kirzek, 2003b; Shiftan, 1998; Rossi and Shiftan, 1997; Limanond et al., 2005). A simple tour contains two stops (e.g. home-work-home) while a complex tour contains more than two stops (e.g. home- work-shop-home, see Figure 2.3).

Figure 2. 3 Tour-based vs. trip-based approach.



Approach	Modelled decision Unit	Trips
Trip-based	1 Home based work trip 3 Non-home based work trips 3 Home-based other trips	1 2,3,4 5,6,7
Tour-based	1 Home-based work tour, with a stop on the way home 1 Work-based tour, with no extra stops 1 Home-based other tour, with no extra stops	1,4,5 2,3 6,7

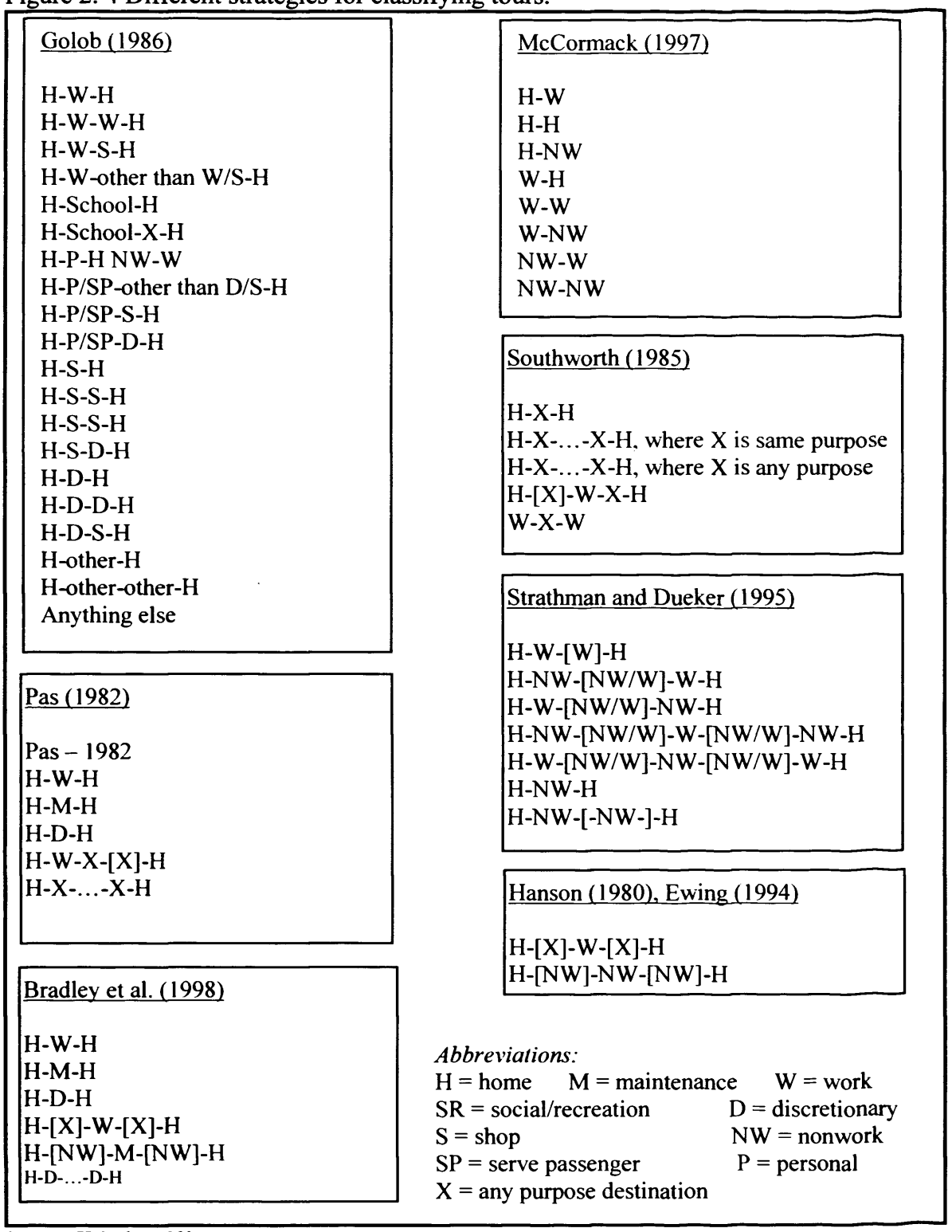
Source: Bradley et al., 1999.

Several tour-based models were developed in the late 1970s and 1980s in the Netherlands (Gunn et al., 1987; Daly, 1983; Hague Consulting Group, 1992). They have been used extensively there and elsewhere in Europe, for example, in Stockholm, Sweden (Algers et al., 1995) and Salerno, Italy (Cascetta et al., 1993), and in US cities such as San Francisco (Bradley, et al., 2001; Jonnalagadda et al., 2001), Boston (Bowman and Ben-Akiva, 2000), and Portland (Bowman, et al., 1998).

The main problem in developing tour-based and activities based models is the multidimensional complex choice set, which includes activity participation and purpose, priorities, sequence, timing, location, travel mode, and route. Using the tour as a unit of analysis raises a question: how to assign a single purpose to what is often a multi-trip/multi-purpose tour? Figure 2.4 presents tour categories used in prior classification schemes. The Figure shows that four of the studies use a binary system, work versus non-work, to differentiate between travel purposes within a tour, whereas Pas (1982) and Bradley et al. (1998) use different activity classifications based on activity type (work, maintenance, and discretionary).

Since one of the present research's objectives is to investigate the interaction among household members' travel decisions, tour based analysis is appropriate for use in the study to analyse the household's work journey. The work journey has received most attention from urban transportation planners. Interest in the daily commute arises from the fact that this is a highly repetitious and therefore highly predictable trip. Also, the journeys to and from work have the greatest impact on the urban transportation system due to their timing in peak periods. Moreover, as a frequent multiple-purpose trip, the journey to work plays a major role in the household's travel pattern. It therefore requires careful examination in order to understand elements of the household's travel decisions (Hanson, 1980; Levinson and Kumar, 1997). Most existing studies deal with

Figure 2. 4 Different strategies for classifying tours.



Source: Krizek,2003b.

the journey to work in terms of a single home to work movement and neglect the fact that the traveller may make stops at retail and service establishments on the way to/from work.

For certain transportation policies, such as those involving public transit, knowledge of which land uses are visited on the way to work, as opposed to on the way home, is of key importance. Studies show there are certain land uses that are frequently visited on the way to work, some that are often visited on the way from work to home (shop, bank, auto repairs and services), and some (restaurant, photo store) that are visited during work time (Hanson,1980).

Studies also reveal the daily travel pattern of workers is characterised by four different patterns: a) the before commute pattern, which represents the activity-travel behaviour undertaken before leaving home to work; b) the commute pattern, which represents the activity-travel behaviour during the home-to-work and work-to-home commutes; c) the work-based pattern, which includes all activity and travel undertaken from work; and d) the post home arrival pattern, which comprises the activity and travel behaviour of individuals after arriving home at the end of the work-to-home commute (Bhat, 2001). Hanson (1980) examined the journey to work as a multi-purpose trip. This study identified the importance of the multi-purpose work trip in the overall travel pattern of urban households. A large proportion of many households' total travel was undertaken in conjunction with the journey to and from work.

Most research on work trip scheduling implicitly assumes that the scheduling of work takes precedence over the scheduling of non-work activities, thus presuming that non-work activities can be successfully arranged around work hours (Picado,1999). It appears, however, that many workers have difficulty balancing work and family obligations. Moreover, these workers are more likely to be female than male, and to bear the largest share of family responsibilities (McRae, 1989; and Hochschild, 1997). The same studies found one-third to one-half of male workers reported work/family conflicts. In addition, the presence of young children in the household often creates

scheduling conflicts between work and home activities (Bhat & Koppelman 1993; Wen and Koppelman, 2000).

2.4.2 Analytic modelling approach

In the preceding sections we have reviewed activity-based analysis. How can the findings of this approach be used in transport modelling and planning? Researchers in the last two decades have sought to answer this question by attempting to incorporate the insight gained from the activity-based travel approach into urban travel forecasting models.

The traditional travel demand forecasting procedure consists of a household base, a cross classification model for trip production, a regression based model for trip attraction, a gravity model for trip distribution, a multinomial logit model for mode choice, and a network assignment procedure for highway or transit travel.

There are two main approaches to activity–based modelling: econometric and hybrid simulation models (Bowman and Ben-Akiva, 2000). Econometric models assume the decision-maker considers all feasible alternatives, or uses a simple search rule to generate a large choice set. Most models are devoted to the complex representation of a utility-based multi-dimensional choice set, and no iteration occurs between choice set generation and choice. Econometric models are systems of equations, which predict the probability of decision outcomes. Econometric models laid the foundation for operational travel models developed in the 1980s and 1990s in the US and Europe (see, for example, Gunn et al., 1987; Algers et al., 1995; Hague Consulting Group, 1997; Rossi and Shiftan, 1997).

Hybrid simulations, on the other hand, focus most of their attention on choice set generation, employing a complex search heuristic which yields a very small choice set. Hybrid simulation examples include the STARCHILD system (Recker et al., 1986);

SMASH (Ettema et al., 1995), and the Activity-Mobility Simulator (AMOS) (RDC Inc.,1995; and Kitamura et al.,1996).

As part of the Travel Model Improvement Program (TMIP) four groups were invited to submit designs for a new generation of travel demand models based on the activity approach (Wachs, 1996). Kitamura et al. (1996), for example, introduced the Sequenced Activity-Mobility Simulator (SAMS), a dynamic and integrated micro-simulation for transportation, land use, and air quality, designed to overcome the weaknesses of conventional travel choice forecasting systems. The activity-Mobility Simulator (AMOS), a component of the SAMS, is a dynamic micro simulator of household activities and travel over time and space. Choice inside the AMOS comprises the activity (type, location, and duration), the trip (time of day, origin/destination and mode), and household interaction. The output from these models is used to derive mobility, air quality and transportation system performance for use in planning and policy analyses.

Ben-Akiva & Bowman (1998) proposed a system of nested discrete-choice models for travel demand forecasting. It is assumed that decisions with different time frames are hierarchically organised. Mobility and life-style decisions (e.g. choosing to purchase an automobile, residential choice) condition longer-term activity and travel scheduling which, in turn, condition daily activity and travel rescheduling. Interrelated choices are assumed to be made for tours, including a primary activity (out of or in the home), the type of tour for the primary activity (the number, purposes, and sequence of activity stops), and the number and purposes of secondary tours. Timing and mode are chosen for tours. A hierarchy of choices is again postulated, this time on the basis of priority. Choices are assumed to maximise utility at each level. A hierarchical

organisation of interrelated choices is assumed, because this restricts the size of the choice sets.

Bowman et al. (1998) claim they presented the first operational implementation of an activity based travel demand model based on work carried out by Ben-Akiva et al. (1996). Their disaggregate discrete choice model system represents an individual's demand for activity and travel as a one day activity schedule consisting of a set of out-home and at-home activities representing total daily demand, trip chaining, the timing, mode and destination of all travel activities. Similar systems have been reported in ALBATROSS (Arentze and Timmermans, 2000), and RDC (1995).

Such models attempt to forecast changes in activity/travel patterns. They also attempt to make realistic behavioural assumptions. However, although considerable progress has been made in the last decade to specify individual and household interactions, which consist of a variety of constraints, family interdependencies and choices over several activity- travel combinations(Hunt et al., 2005), such models are still in their early stages of development and their practical implementation is according to Boyce (1998) some years off. This assessment is still true today.

One of the most important developments in modelling human activity has been the design and delivery of interactive gaming approaches (Fox, 1995). Interactive gaming approaches attempt to apply the theory of activity scheduling and time-geography to practical transportation policies. The household is introduced to a real or suggested change in the transportation system and changes in the household travel behaviour to adjust to the new policies are recorded. The best known and most sophisticated of these models is the Household Activity - Travel Simulator (HATS) developed at the Transport Studies Unit in Oxford University (Jones et al., 1983). Other interactive gaming models have been developed in Canada (Janelle et al., 1981), and the

United States (Hartgen and Tanner, 1971; Cullen and Phelps, 1975; Burnett and Thrift, 1979).

An analysis of behavioural assumptions underlying car-use reduction policies needs to start by asking how travel decisions are made and what factors affect such decisions. A basic tenet of the activity-based travel demand analysis approach is that the main motivation for travel is the desire to participate in out-of-home activities which satisfy needs, requirements, and obligations (Garling et al., 2000).

Activity simulation models have been employed in a number of transport-based policy situations, such as a reduction or increase in transportation services (Martin and Voorhees Associates,1978; Brown and Mawson, 1981), changes to school attendance hours (Jones and Dix, 1978), measuring the likely impact of rail and bus route systems (Jones and Dix, 1978), commute patterns (Ampt, 1981), wheelchair access (Ferguson and Jones,1986), and household adaptation to school bus scheduling (Fox, 1991).

Interactive interview procedures such as the Car Use Pattern Interview Game (CUPIG) (Lee-Gosselin, 1989a, 1989b), the Household Activity Simulation (HATS) (Jones, 1979; Jones et al.,1990), and the Method of Activity Guided Information Collection (MAGIC) (Ettema et al., 1994) aim at investigating how households are likely to change their complex travel behaviour if facing, for instance, increases in petrol cost or legislation limiting the freedom to choose travel during a certain period of time. Respondents are required to state the changes they believe they will make. Thus, the underlying assumption of these methods is that reduced car use is related to changes in an activity schedule (Garling et al., 2000).

2.4.3 Trip chaining: empirical evidence

Trip chaining can be defined as linking trips to visit more than one destination after leaving home (Goulias and Kitamura, 1989). The analysis of trip chaining

behaviour has a long tradition in transportation, geography and planning studies (Hanson, 1980; Thill, 1985; Kitamura, 1987). Many studies have examined the intensity and structure of trip and activity chains. Basic theoretical properties governing the formation of trip chains have been derived by Alder and Ben-Akiva (1979). In their analysis, time and income constraints limit both the coordination of trips and destination choices. The marginal rate of substitution between linked and unlinked trips is equated with the ratio of their respective generalised time and travel costs. An increase in income, for example, will result in a greater propensity to form trip chains.

Clarke et al. (1981) provided important empirical insights into the linkages between trip chaining and household characteristics. They found households comprising young working adults without children developed chains around the work trip to satisfy a greater proportion of their travel activity needs. Households with preschool children had a higher proportion of simple home-destination–home shopping trips and correspondingly fewer complicated work commute chains. Households with school age children experienced increasingly complex passenger and household needs-serving chains. At the mature stage of the life cycle, when children had left home, household trip chains became relatively simpler.

When implementing their daily activity programme, individuals and households can organise their travel in a variety of ways. They may decide to make a single trip for each activity or, at the other end of the spectrum, decide to make a multipurpose, multi-stop tour. According to Strathman et al. (1994):

> *"Transportation planners are interested in learning to what extent the way individuals and households organise their travel patterns is influenced by spatial context, after accounting for socio-economic variables"* (p.102).

The propensity to trip chain is higher on the trip from work to home than vice versa (Lockwood and Demetsky, 1994). Kumar and Levinson (1995) found trip

chaining behaviour was significantly related to gender, mode of travel, and location within the metropolitan region. Yalamanchili et al. (1999) reported that members of smaller households tend to be more heavily involved in trip chaining than members of larger households. According to Kondo and Kitamura (1987), the probability of conducting single-purpose trips increases with the speed of travel, and decreases with commute distance, travel cost and density of opportunities.

Nishii and Kondo (1992) found that non-work stops in after work home-based tours tend to cluster around public transport terminals and around the place of work. Moreover, women are more likely than men to make stops. This finding is consistent with results reported elsewhere (Strathman and Duker, 1995).

Further, stop-making propensity is higher for individuals who live alone or in a couple family household. Spatial characteristics also have some bearing. A higher propensity to make stops has been observed if the workplace is located in a zone with high retail density. In contrast, individuals tend to make fewer stops if they leave work relatively late (Mensah, 1995). Strathman and Duker (1995) concluded that complex chains are more likely than simple chains to occur during the peak period, and the share of simple work chains is greater for higher income households.

Factors which prove to be significant among trip chain types include the life cycle stage, marital status, gender, employment status, education, income, the presence of children, and residential density (Pas, 1984; Golob, 1986; Hensher and Reyes,2000). In their analysis of household travel activity patterns, Recker et al. (1986) found the propensity to form trip chains to be positively related to the number of trips undertaken and negatively related to activity duration, employment status, and age.

Work commutes and non-work trips functionally linked to them have been found to account for a third to over half of all household trips (Oster, 1978; Hanson, 1980;

Damm, 1982; Pas, 1984; Golob, 1986). Nishii et al. (1988) showed analytically that the propensity to link non-work travel to the work commute is positively related to the distance of the commute, travel cost, and the attractiveness of non-work opportunities.

In summary, the trip chaining framework highlights the role of the commute as an organising element in consolidating work and non-work activity. Because trip chaining researchers commonly reach this conclusion, its implication permits emphasis solely on work trips due to their importance in household travel (Strathman and Duker, 1995; Jou and Mahmassani, 1997).

After reviewing the activity-based approach and its operational models, the research turns to studies focussing on the interrelationship between urban form, land use, and travel behaviour. Because of their relevance to policy proposed later by the research, urban form and land use influences on travel behaviour are considered further in the next section.

2.5 Urban form, land use, and travel behaviour

Land use and transport are mutually dependent. Reducing car dependency and minimising travel distance have been important considerations in the planning of New Towns in the post-war period in North America (Crane, 1996; Boarnet and Crane, 2001). Examples include the grouping of local facilities in neighbourhoods so that people can walk to reach them easily (Pharoah, 1996). The integration of land use and transport planning is central to achieving a greater degree of sustainable development, and historically, land use and transport analyses have been strongly linked (Vau and Senior, 2000). According to Newman and Kenworthy (1996):

> *"Three types of cities have been developed as transport technologies have evolved towards greater speed and freedom."*

The first type, the traditional walking city, is characterised by high density (100-200 people per ha), mixed land use, joined together by narrow streets in an organic form that fits the landscape. The second is the transit city: in the latter part of the 19th century, cities spread increasingly outwards as the train and tram allowed faster travel to occur. Medium-density, mixed-use areas were formed at rail nodes and along tram routes. The third type is the automobile city. Since the Second World War, the automobile has progressively become the transport technology that has shaped the city. Together with the bus, it has made development possible in any direction. Low-density housing has become more feasible and, as a reaction to the industrial city, town planning has separated functions by zoning. This has also increased journey distances. The automobile city has also reduced in density to between 10 and 20 people per hectare.

Empirical studies evaluating the relationship between travel behaviour and land use have concluded that specific land use factors can influence travel demand. Cervero (1996) reported that density is by far the most important factor determining what transit mode is used, but that mixed use adds the extra component of encouraging walking. New Urbanism seeks to reconnect the city, and to reassert the importance of land use in making a city sustainable, efficient, equitable and liveable. Newman and Kenworthy (1989) found from their international study of 32 cities that cities of high population density consume less petrol/capita than more dispersed ones. Empirical data at an aggregate level also supports the notion that a high population density and land-use mix results in less travel and also less car travel (Cervero, 1997; Crane and Creapeau, 1998; Cervero, 2002).

Banister (1999) identified three key relationships between land use and transport. As the density of development increases, average trip length, and car use all reduce. Settlement size is also a key determinant of travel pattern. The larger the

settlement size, the shorter the trips, and the greater the proportion of trips by public transport. Location of residential neighbourhoods is the third key determinant of travel.

Several studies have empirically compared existing travel behaviour across different types of areas (i.e. neighbourhoods) within the same region. A study of two neighbourhoods in the City of Portsmouth, New Hampshire (White Mountain Survey Co. 1991) found that, in mixed use neighbourhoods, trip generation rates were considerably lower than general averages.

Ewing et al. (1994) analysed trip records obtained from six communities in Palm Beach, Florida exhibiting a variety of land use configurations for differences in trip frequency, mode choice, trip chaining, trip length, and overall vehicular travel. The "sprawling suburban" community generated almost two-thirds more vehicle hours of travel per person than the "traditional city" community, while other community types fell in between these two endpoints. The authors observed that "density, mixed use, and a central location all appeared to depress car travel".

Table 2.2 lists travel measures used in previous research to link travel behaviour to urban form and land use characteristics. These measures include: travel distance, travel mode, travel cost, and travel purposes. Urban form and land use measures include neighbourhood design (density, street pattern, land use mixed) and accessibility (access to jobs and pedestrian accessibility). Analysis methods vary from descriptive to multivariate statistical analyses and simulation studies.

Table 2. 2 Travel outcome, urban form, land use measures and methods of analysis

Travel outcome measures	Urban form and land use measures	Analysis method
1. Total miles travelled 2. Number of trips 3. Car ownership 4. Mode (e.g. car, rail, transit, bus, etc.) 5. Congestion 6. Commute length (i.e. the journey to work) 7. Other commute measures (e.g. speed, time) 8. Differences by purpose (e.g. for work vs. non-work travel, regional vs. local travel)	1. Density (e.g. simple residential/employment or more complex accessibility measures) 2. Extent of land use mixing 3. Traffic calming 4. Street and circulation pattern 5. Jobs/housing and/ or land use balance 6. Pedestrian features (e.g. sidewalks, perceived safety, visual amenities, etc.)	1. Simulation (i.e. simple hypothetical impact based on assumed behaviour of more complex integrated land use/ traffic impact models based on forecasts of observed behaviour, economic trends, and demographics) 2. Description of observed travel behaviour in different settings (e.g. commute length in big cities as compared with small cities) 3. Multivariate statistical analysis of observed behaviour (i.e. ad hoc correlation analysis of travel outcomes and variables thought to be associated with travel or model specified and estimated according to behavioural theory)

Source: Crane, 2000, p.9.

One way of improving the travel forecast model to link spatial data and statistical data is to apply Geographical Information System (GIS). On account of its power to analyse spatial data, GIS has been used as a tool to evaluate urban form, neighbourhood design, land use mix and accessibility (see, for example, Crane and Crepeau, 1998; Miller and Yi-Hwa, 2000; Krizek, 2003a).

2.6 Complementarity of quantitative and qualitative approaches

A wide variety of quantitative approaches have been used to study household travel behaviour. Section 2.2 presents an overview of the development of quantitative tools applied in travel behaviour modelling. Quantitative approaches have continued to dominate urban transport models, possibly due to the influence of engineer practitioners who tend to use statistical tools more than other tools available in the field (Røe, 2000).

Although quantitative approaches have established a sound reputation in the travel behaviour field, there is still a gap in these approaches which needs to be filled using qualitative methods.

Qualitative methods, used in conjunction with quantitative approaches, or on their own, offer powerful tools for improving understanding of the complexities of travel behaviour. This is because qualitative methods, including focus groups, interviews, and participant-observer techniques, can help fill the gaps left by quantitative techniques. The reliance on survey data only for forecasting and decision making has come under fire for a number of reasons. First, surveys are often used in circumstances when the issues under study are already clearly defined and participant responses are anticipated. The survey instruments thus frame the questions and limit the range of answers to those questions. Second, data collection methods using traditional travel diaries or telephone recruitment can under-represent certain segments of the population, particularly the elderly, persons with little education, minorities, and the poor (Clifton and Handy, 2003).

Qualitative methods can also be used to improve both the design and interpretation of traditional surveys. Before the survey, focus groups, for example, can be used to identify which socio-demographic variables to include in the survey, how best to structure the diary, even what incentives will be most effective in increasing the response rate. After the survey, focus groups can be used to build explanations for the survey results, to identify the "whys" of the results as well as the implications. Clifton and Handy (2003) comment:

> *"Qualitative techniques can bring survey results to life, providing the stories and examples that help us to understand what the numbers mean." (p.3)*

Applying qualitative data techniques has produced important new insights into travel behaviour that increases our ability to understand and address transportation problems. Interviews can provide the same rich, situational response as focus groups. Because interviewees are interviewed individually, the confidentiality issues and normative pressures that often characterise focus groups are not as problematic. The interview format provides a more intimate setting for discussion of sensitive issues or very personal matters, and more detailed information about the individual or household circumstance can be elicited. Also, because the respondent is answering questions in the presence of an interviewer, there is an opportunity for clarification, explanation, and elaboration of questions and responses.

Semi-structured interviews were employed by Clifton (2001) to identify the mobility constraints of low-income households, the factors contributing to automobile purchase, and short-term coping strategies used to gain the mobility required for non-work activities. Poulenez-Donovan and Ulberg (1990) used semi-structured interviews to uncover factors that were influential in employees' decisions to participate in an employer-based Travel Demand Management (TDM) programme. Findings revealed unanticipated factors which would have been excluded from a traditional questionnaire survey.

In conclusion, after reviewing both approaches, quantitative and qualitative methods are each seen to have their own advantages, but they have seldom been combined to analyse policy changes.

2.7 Research gaps and implications for further study

Although travel behaviour has been studied for the last fifty years, there is still considerable uncertainty about the key parameters influencing it. The field of transportation modelling has gained from the development of behavioural based

approaches, but it is still too early to see such full richness of the activity-travel approach in the form of practical improvements in transportation modelling. The majority of the work in this field employs quantitative methods, and qualitative techniques have been less utilised, although they are very powerful for understanding households' likely responses to changes in transport policies.

The activity-based approach, a cornerstone in the development of travel behaviour field in the last two decades, has proved its ability to produce its own analytical technique, i.e. tour-based analysis, which overcomes the drawbacks of trip-based models. Most activity-based travel behaviour studies have been conducted in Western countries. However, this approach is now sufficiently mature to be applied in a different cultural environment (e.g. the Islamic world). The influence of cultural factors on travel behaviour has rarely been mentioned in the travel behaviour literature. Therefore, the impact of cultural factors, such as social customs and traditions, on travel behaviour needs future investigation.

The above factors identify promising research areas to fill the gaps in the literature. On theoretical grounds, it is felt that the application of the activity-based approach in a different cultural environment, using both quantitative and qualitative methodologies and introducing new parameters to test the importance of disaggregate accessibility measures and cultural factors, will provide a useful contribution to the field of travel behaviour studies.

CHAPTER THREE

Research Design

3.1 Introduction

This chapter puts forward a conceptual framework for this research, presenting the theoretical base for the study and identifying the sets of factors which it is hypothesised might affect household travel decisions. The statistical analysis in this study can be divided into two parts based on the study objectives. The first part focuses on factors influencing the trip generation rate and adopts Poisson regression analysis to establish the quantitative relationship between the number of car trips per household and household characteristics and neighbourhood land use attributes. The second part of the statistical analysis attempts to show the variation in journey to work tour types utilising the Multinomial Logit (MNL) model. The dependent variable in this model is the probability of a household head selecting various tour types.

The qualitative approach in this study applies in-depth interviews in an attempt to understand household travel decisions and the likely impact of proposed policies on household travel behaviour.

This chapter outlines the research methodology required to address the study objectives presented in chapter one. Data collection methods are detailed. The processes of sample design, selection of neighbourhoods, conduct of the survey and building the study's data base are described.

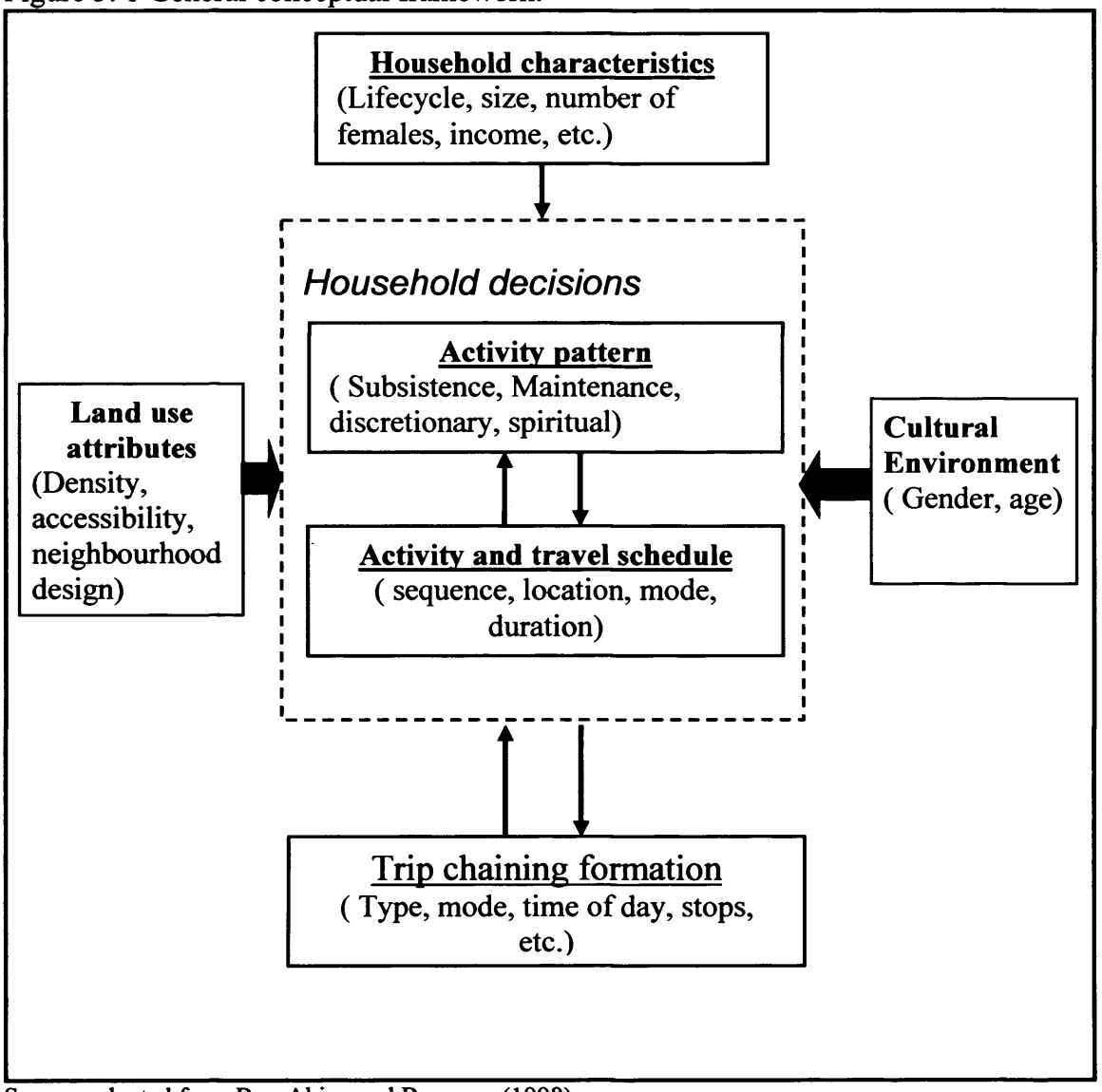
3.2 Conceptual Framework:

A conceptual framework is derived for this research to show the nature of household travel decision. An activity-travel framework forms the basis of the conceptual framework of the current study. This approach reveals travel patterns in the context of a structure of activities of individuals or households within a framework emphasising the importance of time and space constraints (Goodwin, 1983).

The conceptual framework for the study is presented in Figure 3.1. The proposed framework considers household travel decision, activities, cultural influence, land use characteristics, and tour formation. This conceptual framework suggests that a household's travel decision is an outcome of individual preferences and constraints which limit the household's choices. The framework shows how household members compromise between existing alternatives (i.e. travel mode, travel route, and travel times) because of constraints which limit their travel choices (e.g. time, resources, and the household head's commitment to other household members' travel needs). According to the conceptual framework, the travel decision is influenced by household characteristics, for example, lifecycle, since a newly married couple will have a different lifestyle from a household with five children. Household characteristics crucially influence mobility. For instance, a household with a chauffeur can perform more out-of-home activities than a household without a chauffeur. The study focuses on exploring the impact of the cultural environment and land use characteristics in the decision process on Saudi households. The impacts of cultural and land use factors will, in turn, influence tour formation. The study assumes that the characteristics of three factors (household characteristics, land use attributes, and

cultural environment) will play a role in increasing or decreasing the interdependency of household activity pattern which will be reflected in tour formation.

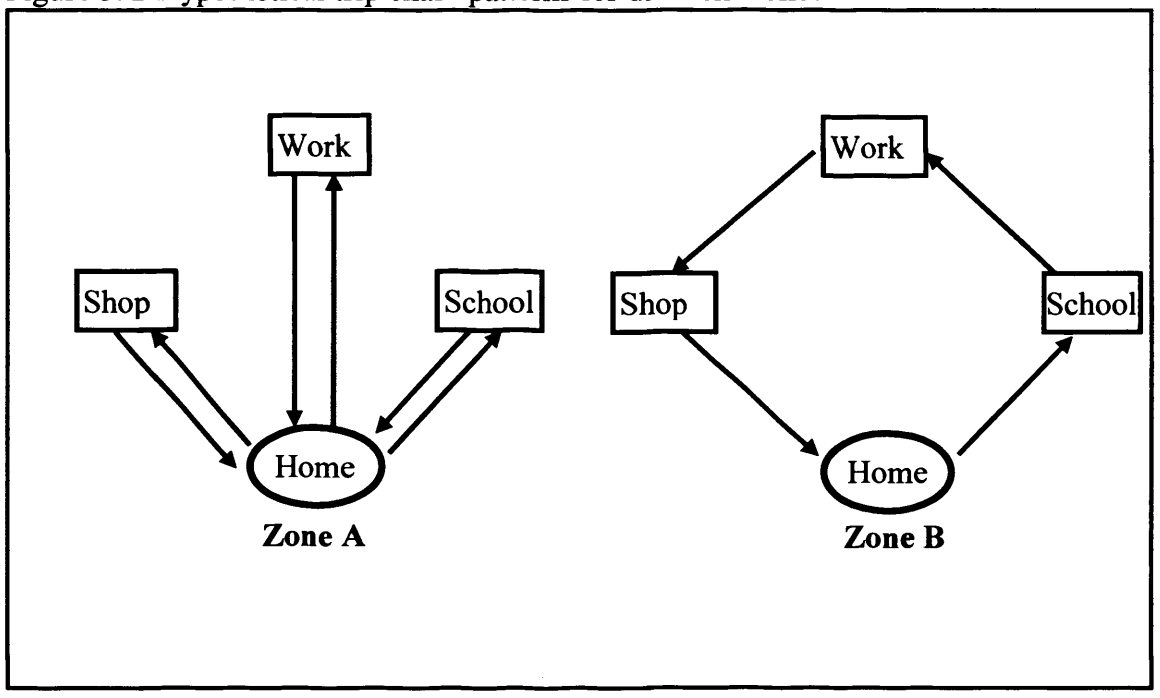
Figure 3. 1 General conceptual framework.



Source: adapted from Ben-Akiva and Bowman (1998).

For example, members of a household living in a high density and mixed-land use area, zone A, will tend to be less dependent on each other (i.e. children will usually walk to school) and the tour will tend to be simple (see Figure 3.2). In contrast, households living in low density and residential neighbourhoods will tend to more carefully co-ordinate their travel activities to accommodate all household members' needs.

Figure 3. 2 Hypothetical trip chain patterns for different zones



In the empirical work, the influence of household characteristics, cultural factors, and land use attributes will be tested in relation to two measures of travel: the propensity to engage in trips (trip generation rate) and the probability of selecting a particular travel pattern (tour type). In addition, the study examines the impact of possible policy changes. The reaction of households to proposed new policies will be elicited to ascertain to what extent proposed policy changes may affect their travel activities. Policies, such as introducing a free school bus, will interest households with children attending school, while households with no children will have no direct interest in such policies since they will not impact on their travel decision. All households participating in the empirical work will be asked to consider how proposed policy changes will affect their travel activities, any constraints they may impose, or adaptations they may have to make to fit the new situation.

3.3 The Statistical models adopted

Two statistical models will be adopted to address the first study objective, to characterise the travel behaviour and identify determinants of travel behaviour in

Saudi household. The first model focuses on developing household trip generation rate. The second part deals with tour type selection.

3.3.1 Trip generation model

This model estimates the number of car trips generated by all household members in a twenty-four hour period. It is thus a disaggregate model because the observations relate to individual households. A Poisson regression model is used to estimate the parameters of the variables used to explore the association between the number of car trips rate per household and independent variables. Poisson regression is appropriate when the response outcome is in the form of a count and the values are small (Lovett and Flowerdew, 1989). Poisson regression modelling is very rare in travel behaviour research: one of the few examples, on inter-city rail trip frequencies, is Rickard and Hill (1991). This is surprising given the appropriateness of Poisson regression for small counts like trip generated per day. The main assumptions underlying Poisson regression are that dependent variables are Poisson distributed and, as in other types of regression models, explanatory variables should not be strongly correlated. The Poisson regression model formula is as follows:

$$T_j = \exp(\beta + \beta_1 x_1 + \beta_2 x_2 .....) + \varepsilon_j^P$$

Where:
T_j= number of car trips per household j,
β = constant
β_1, β_2,... = parameter values applied to independent variables
x ,x_2.....= the set of explanatory variables
ε_j^P = Poisson error terms
The explanatory variables will consist of three groups as shown in Table 3.1: household head characteristics, household characteristics, and land use characteristics.

Thus, the trip generation model will be as below:

T= f (H, S, L, β)

Where:

f = functional form
T = number of car trips per household
H= household head characteristics
S= socio-economic characteristics
L= land use and access characteristics
β = set of estimated parameters associated with these explanatory variables

Specification of the trip generation model will be discussed in detail in Chapter Six, Section 6.3.2.

Table 3. 1 Explanatory variables used in the trip generation model

Household head characteristics	Household characteristics	Land use and access characteristics
• Age • Education • Occupation • Working sector • Income	• Household size • Children aged under 6 • Boys in school • Girls in school • Car ownership • Availability of a chauffeur • Number of drivers • Male in work • Female in work	• Density • Distance to CBD • Distance to mosque • Distance to schools • Distance to work

3.3.2 Tour type model:

As part of the first objective, this model estimates the probability of a household with postulate characteristics selecting a tour type. The tour is defined in this study as a sequence of trip segments that start at home and end at home (Shiftan, 1998). This study uses the tour based model because of its ability to capture more of the behaviour interaction than the trip-based model approach (Bradley et al., 1999). As can be seen from Table 3.2, tours are defined based on the number and time of secondary stops.

The main activity is defined based on the time consumed in the activity. For example, if an individual visits a friend for one hour and then goes shopping for an hour and a half, the main activity of this tour will be recorded as shopping. Figure 3.3 presents examples of tour typology.

A Multinomial Logit (MNL) model will be used in this part of the analysis. The dependent variable is the probability of the four tour type choices (Figure 3.4). The MNL is used when dealing with three or more unordered choice option, which is the case with tour types. If interpreted as a discrete choice model based on random utility maximisation, the MNL involves assumptions about the disturbance terms of the utilities: they are independent, identically distributed and Gumbel distributed (Ben-Akiva and Lerman, 1985). The explanatory variables consist of household head, household characteristics, and land use attributes.

Table 3. 2 Tour type characteristics

Tour type	Definition	Example (work is the main destination)
Simple	A tour without any secondary stops	Home-work-home
Complex tour to main destination	A tour containing one or more secondary stops on the way to the main destination	Home- shop-work-home
Complex tour from main destination	A tour containing one or more secondary stops on the way home from the main destination	Home -work- school - home
Complex tour to and from main destination	Two or more secondary stops both on the way to and from the main destination	Home-school-work– school- home

This model estimates the probability that a household with a set of characteristics selecting a tour type as:

Tour type = f (household head characteristics, household socio-economic characteristics, land use attributes)

In terms of the probability a household head will select tour type j when:

$$P_j = \frac{e^{\delta' H + \beta' S + \kappa' L}}{\sum_{j=1}^{J} e^{\delta' H + \beta' S + \kappa' L}}$$

j= tour type (four categories)

Where:

δ' = is the set of estimated parameter values applied to household head characteristics

β' = is the set of estimated parameter values applied to household characteristics

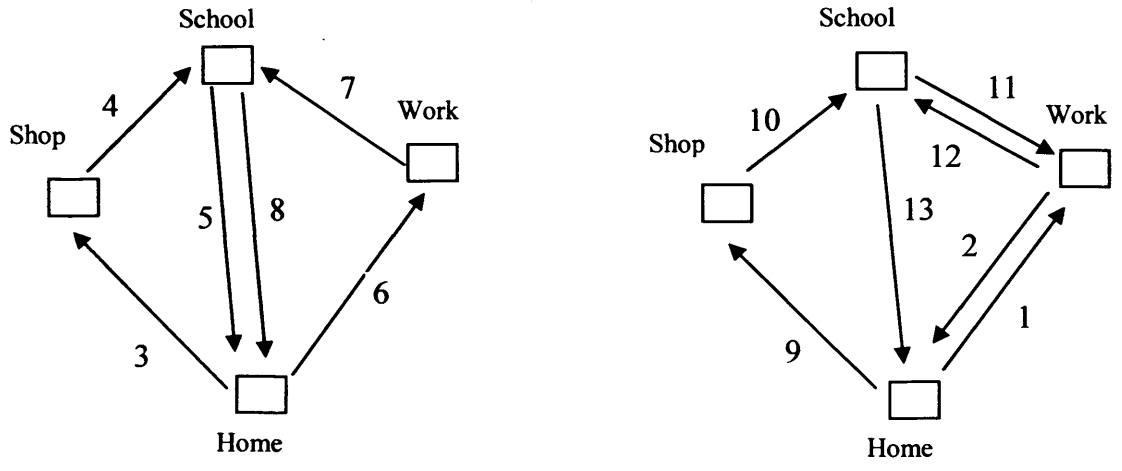
κ' = is the set of estimated parameter values applied to land use characteristics

H = represents the set of characteristics of the household head

S = represents the set of characteristics of the household

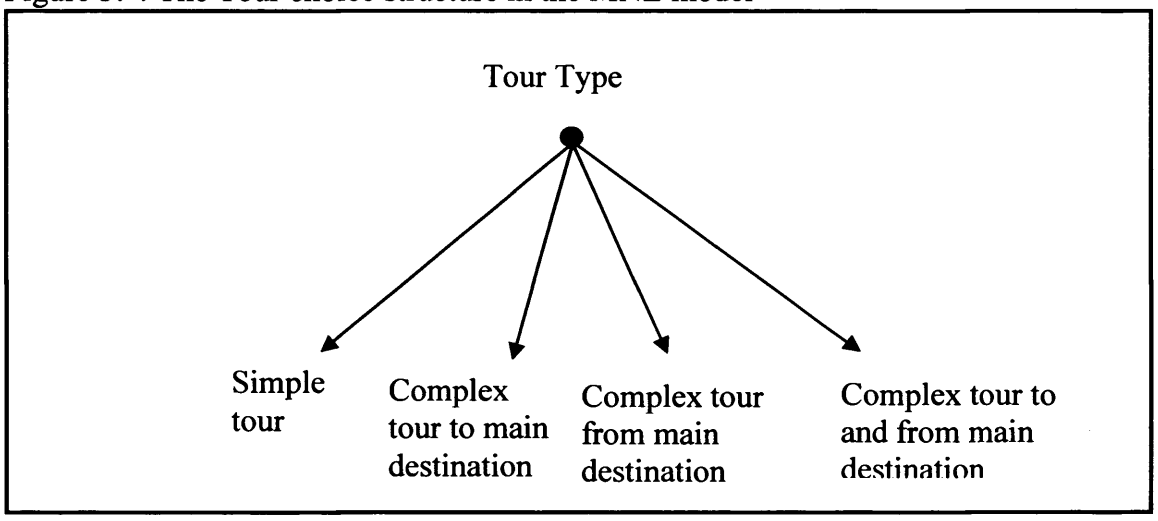
L = represents the set of land use characteristics

Figure 3. 3 Examples of tour types



Tour type	Tour description	trips
Simple	Home-based work tour with no stops	1,2
Complex to	Home-based other tour with one stop on the way to the main destination (school)	3,4,5
Complex from	Home-based work tour with one stop (school) on the way home from the main destination	6,7,8
Complex to and from	Home-based work tour with two stops (shop and school) on the way to the main destination and one stop (school) on the way home from work	9,10,11,12,13

Figure 3. 4 The Tour choice structure in the MNL model



3.4 Qualitative research methods

The stated intention method will be adopted to address the second objective of this study. Semi-structured interviews will be used to understand households' travel decision and their response to proposed transport-related policies. The rationale for interviews is to give interviewees the opportunity to describe their experiences in their own words, to understand how they organise their activities according to their circumstances. Semi-structured interviews allow interviewees to express their opinions, concerns, and feelings. This method of data collection benefits from several advantages, such as giving the freedom to explore general views or opinions in details, and allowing comparisons between interviewees' opinions and views (Oppenheim, 1992).

3.5 Survey design

The research required the collection of quantitative and qualitative data. To gather all the data needed for the research, four types of surveys were undertaken: questionnaire, semi-structured interviews, field surveys, and secondary data collection.

3.5.1 Questionnaire design

The questionnaire was designed to include questions eliciting details about household characteristics and travel activities, and consisted of three parts: the household head's characteristics, household socio-economic characteristics, and travel activities made on the day prior to the interview (see Appendix 1 for a copy of the questionnaire).

The first part of the questionnaire focused on collecting data about the household head who, in most cases, is responsible for activities associated with travel due to cultural factors (women are not allowed to drive cars in Saudi Arabia). This part sought to elicit information related to the household head's level of education, employment sector, working hours, and monthly income. These characteristics were expected to influence the household head's travel behaviour, for example, educational level was thought likely to influence household characteristics, social prestige, and travel choices and decisions. Details of the household head's employment sector were elicited in order to ascertain the influence of employment sector on travel activities. Some sectors will permit flexible working arrangements enabling employees to leave the workplace within working hours to serve other household members' needs. This section also sought details of the exact working hours household heads. Those employed in the public sector normally work between 7:30 am and 2:30 pm, and those in military jobs between 6:00 am to 1:30 pm. In the private sector, employees may work from 7:00 am and 3:30 pm or work in two shifts, for example, from 8:30 am to 1 pm and from 4:30 pm to 7:30 pm.

The second part of the questionnaire sought information related to household structure and travel needs. In this part, questions focused on the number of cars, number of drivers, availability of a chauffeur, and number of children under school

age and data related to other household members above 6 years old, excluding the household head. These included details of age, gender, relation to the head of the household, and occupation.

Part three of the questionnaire aimed to collect data on travel activities. Based on travel modes, the household head was asked to recall all trips made on the day prior to the interview. Interviewees were asked to report all trips, with each stop counting as a separate trip, and to recall details such as who was the driver, where the trip started, where the trip ended, the trip purpose, time of trip, and who had been with the driver. These details were collected for travel in each car owned by the household. For other travel modes, information was sought on who was the traveller, travel time, travel mode, trip origin, destination, and trip purpose.

Due to the lack of a local address system to locate places in Dammam City (i.e. street name, house number, or postal address), interviewees were asked to indicate the house location and all destinations visited on a map provided by the interviewer in order to measure the exact distance(s) travelled. This method may have been time consuming but it provided more accurate data than simply asking interviewees to assess the distance travelled or provide details of street locations.

Finally, interviewees were asked if they would be willing to be interviewed again by the researcher. Potential interviewees were selected according to specific criteria such as: household size, location, income, travel activities, and tour type(s) performed by the household. The questionnaire data formed the basis for quantitative analysis by providing detailed information on participant households and their travel activities.

3.5.2 Semi-structured Interview

Interviews aimed to understand why households performed various types of tour and to measure the effect of proposed land use and transport related policies designed to reduce the number of car trips, on household travel behaviour.

The stated intention method was used by the researcher for this part of the analysis. Interviews provided an opportunity to explore people's views on proposed policies related to travel behaviour. Interviewees were asked questions such as why they stopped at a particular destination or performed a trip at a particular time. They were also asked to indicate on a Likert style scale (i.e. strongly agree, agree, disagree, strongly disagree, and do not know) whether proposed policies would be sufficient to reduce their car trips and, if so, how the reduction in number would impact on household travel activities (see Appendix 2 for interview form).

The semi-structured interview data formed the basis for qualitative analysis to understand the constraints on household travel decisions. Also, interviews afforded the researcher the opportunity to evaluate how policy changes in land-use and transport might influence household travel behaviour in the future.

3.5.3 Field Survey

Data related to neighbourhood characteristics were collected for use in the quantitative analysis, including land use and density; commercial and social services' spatial distribution, and the location of facilities in order to measure the network distance between respondent's homes and targeted destinations.

3.5.4 Secondary data

Data related to urban transportation in Saudi Arabia (i.e. policies, goals, challenges) are important in order to understand the current situation on a national scale. The same information at the local level in the study area is also important, in addition to that provided in previous studies and reports focusing on road networks,

travel modes and public transport. In order to link land use and urban transportation, a base map of Dammam city, a land use map, and other related data are essential. Secondary data were collected through visits to governmental bodies, both at the local and national level, and educational institutions. i.e. the Ministry of Municipalities and Rural Affairs (MOMRA), the Ministry of Communication, Dammam Municipality, Saudi Arabian Public Transport Company (SAPTCO), Dammam Housing Project Authority, King Fahad University for Petroleum and Minerals (KFUPM), and King Faisal University (KFU)

3.5.5 Questionnaire survey and semi-structured interview validity

One of the most important tasks in any research project is the construction of an appropriate data collection tool. In order to test the validity of the questionnaire survey and semi-structured interview, a pilot study was conducted in Cardiff with six Saudi postgraduate students studying at the University. They were asked to comment on the questionnaire contents and structure, as well as clarity and ease of response. The time taken to complete the interview was measured, the coding of the answers was practised to identify any difficulties, and overall results were viewed to ensure the study instruments produced the data that were required.

Pilot study questionnaire respondents suggested that, when asking about monthly income, income categories should be provided rather than an open-ended question. They emphasised the importance of introducing the goal of the study because the questionnaire sought private details, e.g. household members' age, occupation, income, and detail of household members. These comments were taken into consideration when producing the final version of the questionnaire.

3.6 Survey implementation

In this study, a personal face to face questionnaire method was adopted for two reasons. First, respondents were unlikely to be familiar with travel-related questionnaire concepts such as trip, trip purpose, and tour. Interviews would allow the researcher to explain these concepts clearly to participants. Second, Saudi households are not familiar with data collection methods, such as mail questionnaires and phone surveys; the former because there is no reliable postal system and the latter because it is socially unacceptable for a male non-member of a family to interview a female member if she picks up the phone.

The study used multi-stage cluster and systematic sampling (Vaus, 1991). First, Dammam was divided into neighbourhoods based on the Dammam Municipality map. Second, seven neighbourhoods were selected from among forty neighbourhoods in Dammam. These neighbourhoods were chosen because they represent varied socio-economic characteristics, land uses and neighbourhood design. Third, a sample of blocks in each neighbourhood was selected based on different distances to services (schools and mosques). In the fourth stage, households were systematically selected using the parcel number. Even and odd numbers were alternatively selected to ensure householders participating in the questionnaire survey represented the whole block (for example: 10,21,32,43, etc.)

The accuracy of models used in any research depends on sample size. Accuracy is not the only factor to consider when working out the sample size, cost and time are also key factors. The final sample size determined is a compromise between cost, accuracy, and ensuring sufficient sample size (Vaus, 1991, p.73). Badaban (2001) commented "traditional practice in transport modelling has been to

use as a rule of thumb 15-25 observations per explanatory variable in statistical analyses".

In the present study there were 37 variables. Accordingly, 420 questionnaires were distributed (11 observations for each variable). If we compare the ratio of distributed questionnaires to statistically significant variables in the statistical analysis, we find 27 observations per variable. Table 3.3 shows the distribution of sampled households in selected neighbourhoods.

Table 3. 3 Questionnaire distribution

Neighbourhood	No. of distributed questionnaires	No. of valid questionnaire
Al-Khaleej	80	61
Jamayyen	70	69
Iscan	65	63
Gharnata	60	57
Al-Roabi	60	58
Al-Aziziah	52	44
Petrumin	33	28
Total	420	380

In order to conduct face-to-face questionnaire surveys with selected households, it was necessary for the researcher to seek assistance to complete data collection within the planned timetable of three months. The researcher and five students participated in questionnaire interviewing.

An introductory session was held by the researcher to introduce the purpose and importance of the study to the five students, explain the questionnaire contents, and show students the selected neighbourhoods. Students were advised on how, when, where, and to whom they should ask questions. Each question in the questionnaire was introduced, explaining its importance, how it should be asked, the anticipated

responses, and how they should be recorded. Each interviewer was provided with a letter from the researcher's institution declaring the nature and purpose of the study and confirming the confidentiality of data (see Appendix 3). Each student visited the field site and conducted one questionnaire survey as a pilot study in order to practise asking questions, recording answers, and answering interviewees' queries. The researcher checked students' work and reviewed the process with them. Each day the researcher met students at an agreed location in one of the selected neighbourhoods and gave them copies of the questionnaires and a map showing the houses where householders were to be surveyed. At the end of each day, the researcher collected completed questionnaires and agreed with student where they would meet the next day.

Distribution and completion of the face to face questionnaires took 20 days to complete, five days a week over a period of four weeks. Because the travel diary covered the five working days Saturday to Wednesday, questionnaire surveys were carried out on Sunday, Monday, Tuesday, Wednesday, Thursday, and participants asked about their travel behaviour on the day prior to the survey.

The second stage of primary data collection started as soon as questionnaire data collection had ended. Semi-structured interviews were designed to be conducted with the household head. Based on household characteristics and household travel activity, 33 households were selected for interview.

The researcher interviewed all the selected household heads who had agreed to participate in the further investigation. Household details were available from the initial collected questionnaires (i.e. household travel activities, household characteristics, the household head contact detail, and the household location). So, before visiting each selected household, the researcher phoned the household head

and agreed a time convenient for him to visit his house to conduct the interview. The researcher wrote down interviewees' answers instead of tape recording them because many people are wary of tape recordings, and to encourage them to talk openly and freely. Semi-structured interviews took 13 days to complete.

3.7 Building the study's database

The researcher collected all his primary and secondary data during his field trip, which lasted for four months between October 2002 and January 2003. The researcher chose this period because it was school-time and he could record all usual household travel activities.

The first task was to obtain from Dammam Municipality a base map for Dammam showing neighbourhood boundaries and detailed plans of the selected neighbourhoods for questionnaire survey and interview purposes. However, plans showed only the outline of neighbourhoods at the design stage and the parcel number which would be used later to select the household samples. No plan showed the existing situation of land uses, building type, residential unit numbers, or developed or vacant lands. The researcher carried out his own field survey for each selected neighbourhood, identifying land uses and the location of services, i.e. schools, mosques, health services. Thus, he produced new, updated maps of the seven neighbourhoods, showing existing services. (See Chapter 4, Section 4.9 for maps)

The researcher also gained access to neighbourhood surveys produced by the Saudi Telecom Company (STC), which provided detailed information on residential and commercial uses, including the number of units and developed or vacant lands.

The next stage was producing a map of each neighbourhood where each household's parcel number was marked on the map. This map was attached to each

questionnaire so that the interviewer could mark the services used by the interviewee from each household interviewed.

Data coding and database entry took place in Cardiff after the researcher had completed his field trip. To record the information derived from questionnaire and travel diaries, data were divided into three separate files in MS Excel format which can be used in most statistical packages. In the household characteristics' file, data entered included the details of 380 households (see Table 3.4).

Table 3. 4 Contents of the household characteristics' file

Household head characteristics	Age, education, occupation, employment sector, working hours, and income
Household characteristics	Household size, availability of a chauffeur, number of persons available to drive, number of cars, children aged under 6, boys in school, girls in school, school children, unemployed persons above 18, males in work, females in work, housing tenure

File 2 included the characteristics of household tours. Members of the 380 households performed 2747 tours. The details of these tours were entered in this file as shown in Table 3.5.

Table 3. 5 Contents of tour characteristics' file

- Tour identification number
- Tour's main purpose
- Tour's start location
- Tour's start period
- Tour's end period
- Tour mode
- Tour Traveller
- Number of trip legs
- Tour's secondary stop purpose
- Number of passengers
- Passenger types
- Tour Type
- Tour Typology

File 3 contained both household characteristics and tour attributes. This file was produced automatically using SPSS version 11, and linked the travel activities to the household characteristics. The above three files provided the basis for the statistical analyses. The researcher's next task was to build a geographical information data base.

During the field trip, the researcher collected data about Dammam, particularly the selected neighbourhoods and their land uses and services' distribution. However, all the data had been produced by different authorities for different uses using different scales and different formats. Moreover, the information was in hard copy (i.e. paper maps). The researcher successfully obtained a digital copy of Dammam base map produced by the electricity company (SCECO) in AutoCAD format. Using Arcinfo 8, the Dammam base map was converted for use by ArcView3 version 2. This software was used due to its capability to sort, analyse, and present geographical data.

There was no comprehensive planning inventory for individual neighbourhoods in Dammam and extensive effort was involved in compiling a land use database. This was achieved by combining data from the Saudi Telecom Company, the local Planning Department and from the author's field survey. Different authorities have their own databases of land uses according to their own purposes and there were differences in the database collection dates. The researcher combined data of land use according to land use categories which served the study objectives. Land use categories include residential, commercial, mixed use (residential and commercial), governmental buildings, schools, mosques, parks, and vacant lands. The study used the field survey to clarify and update land use categories to overcome the difficulty of combining different databases using different categories.

The original base map showed only the parcel number and boundary, as there were no data at all relating to land use, density, or number of residential units. It was therefore the researcher's job to organise data obtained from different authorities and sources using different scales. After this organisation, the researcher entered data for 9,676 parcels in six neighbourhoods, the seventh neighbourhood Iscan was not included because it differed from other neighbourhoods, consists of 32 tower blocks. For each parcel, the land use data and number of residential units were entered. Existing services locations were entered and the sampled households' ID were entered and linked to the travel activities' file in Excel (see Table 3.6). After entering the locations of sampled households and services, distances between households and services, workplace and the city centre, were produced using the Network Analysis facility in ArcView3 version 2. Distances to services were obtained by applying the closest facilities technique using the Network Analysis routine in ArcView. Network distance from home to services, the CBD, and place of work were measured using only distance not travel cost or travel time. These data were subsequently transformed into Excel format to merge with household characteristics' and travel activities' files.

Table 3. 6 Contents of GIS database

Parcel attributes	Accessibility measures
• Number of residential units per lot (unit/lot) • Area (m^2) • Land use (Residential, commercial, mix land use, etc..)	• Distance to nearest boys' primary school • Distance to nearest girls' primary school • Distance to the CBD • Distance to place of work

GIS usage facilitated comparison between selected neighbourhoods, including percentage of residential uses, percentage of commercial uses, percentage of service uses, number of residential parcels, percentage of developed lands, percentage of

vacant lands, average network distance to services, average number of residential units per parcel, number of residential units, and neighbourhood area.

3.8 Summary

In this chapter, the conceptual framework for addressing the study objectives has been presented. The statistical analysis will be divided into two components: a model of trip generation using a Poisson regression model and a Multinomial Logit (MNL) model consisting of four tour type choices.

The chapter subsequently discussed the survey design and implementation. The research conducted primary and secondary data collection. A face to face questionnaire and semi structured interviews were used to collect data related to existing travel activities and possible changes as a result of proposed new policies. A total of 380 questionnaires were collected and 33 interviews were conducted. Data related to neighbourhood characteristics were obtained using a field inventory and secondary sources. The data collected were processed and computed by the researcher to provide a rich database.

The following chapter will provide background details on the study area. Dammam will be described in detail, providing the reader with essential information before discussing the results from the empirical study.

CHAPTER FOUR

Study Context and Urban Transportation Administration and Issues

4.1 Introduction

In order to convey an idea of the study area context for this research, some essential background information about the city of Dammam will be provided. The issues discussed in this chapter are selected for their relevance to the scope of the study, and their role in influencing household travel decisions. This chapter consists of two parts: part one provides background details of the transportation system in Saudi Arabia. Part two describes the study area context. Section 4.2 attempts to survey the planning and transportation administration systems in the country. Issues transportation planners have to deal with will be reviewed in section 4.3.

Part two of this chapter presents detailed information about the city of Dammam; its location and function, natural environment and population growth are described in sections 4.4, 4.5 and 4.6, respectively. An outline of urban development in Dammam is provided in section 4.7. Neighbourhoods and their attributes are discussed in section 4.8. Detailed information about selected neighbourhoods' socio-economic and physical characteristics is included in section 4.9. Section 4.10 describes Dammam's urban transportation infrastructure, including a description of existing travel mode options available in the city.

4.2 Transport administration in Saudi Arabia

Several different governmental bodies are responsible for transport administration in Saudi Arabia. They include the Ministries (at the national level) and their regional and local departments.

4.2.1 Ministry of Transport

The Ministry of Transport was previously called the Ministry of Communication until 30-4-2003 when its name was changed. The Ministry of Communication was established on 7-9-1953, and a royal decree gave the Ministry responsibility relating to: telex and postal services, roads, railways, and all departments dealing with communication. Later on, the Ministry of Telex, Telegraph and Telephone was established. The Railways Public Authority and the Ports general establishment were subsequently set up. As a consequence, the Ministry of Transport, formerly the Ministry of Communication, was left with the following duties to implement:

- To build, maintain and operate roads and bridges between cities and villages.
- To build and maintain ring roads and primary roads in major cities.
- To prepare and conduct technical and economic studies of the transport sector.
- To introduce and publish statistical data relating to transport modes (Alansary et al. , 1999, p.528).

The Ministry of Transport has conducted feasibility studies relating to road networks linking Saudi cities. These studies have been prepared by private consultants, but due to lack of population data, the absence of land use data, and traffic volume and travel pattern studies, these studies have been based on

assumptions which has led to deficiencies in their outcomes (Abdul Ghani and El-Shabani, 1989).

The Ministry supervises the Saudi Arabian Public Transport Company (SAPTCO) which runs public transport services. This company has the right to run public buses in Saudi cities. The Ministry approves all new bus routes and changes in services.

Private mini-buses, taxis, limousines, school buses and coaches running between cities must be registered and authorised by the Ministry of Transport. Like all Ministries, this Ministry is located in Riyadh, and there is a General Directorate of Transport and Roads in each region.

4.2.2 Ministry of Municipalities and Rural Affairs (MOMRA)

The MOMRA is the body responsible for physical development in urban and rural areas in Saudi Arabia. All municipalities report to the MOMRA. The Deputy of City Planning (DCP) is one of five deputies in the MOMRA. The DCP is the national body responsible for providing all urban development strategies and studies and operating and controlling urban development in Saudi Arabia. (MOMRA, 2002,p. 178). The DCP aims at reaching comprehensive physical development in both urban and rural areas. The main tasks of the DCP are:

- To develop general policies relating to urban development
- To produce regional and physical plans for all regions and cities
- To give technical support to municipalities and village clusters in relation to urban planning issues.

The DCP consists of many general directorates. The General Directorate of Transport and Traffic Planning (GDTTP) has been established recently in order to cover transport, traffic and safety planning and protection of the environment. It also

assists in establishing the local directorates of transport and traffic planning in municipalities in order to manage, operate and control traffic in Saudi cities (MOMRA, 2002, p. 185). Unfortunately, due to its very recent establishment, the GDTTP does not have a clear role or influence on the DCP's decisions relating to urban development. The DCP still does not have a strategy or clear policies in relation to urban transportation. In all master plans or structural plans of Saudi cities, the DCP deals with transportation as a chapter in the final report containing simple data obtained from household interviews and traffic counts on major roads. These studies provide basic descriptive data about journey characteristics in cities under investigation, e.g. travel mode, travel purpose, travel time, and O-D survey (ArcePlan, 1995). Saudi families have not been approached to obtain travel diaries for 24 hours or a week to ascertain the structure of household travel activities. Most previous studies have not tried to link travel decisions to household or individual characteristics. Although the DCP is the national body responsible for urban development and city growth, it is hard to find a study highlighting the relationship between land use, urban development, city growth and transportation in Saudi cities. It is the DCP's role to propose policy and regulation, which will influence cities' growth, but the DCP has not done this. This may be due to the fact that the DCP relies on other Ministries, such as the Ministry of Transport, to play such a role.

4.2.3 General Directorate of Traffic (GDT)

The Public Security establishment is the national body which is in charge of the security and safety of the public. The General Directorate of Traffic (GDT) is one of several directorates which reports to the Public Security establishment and is the national department responsible for the operation, control and management of traffic in Saudi cities. The GDT is located in Riyadh and has regional offices in each capital

of the 13 administrative regions in the country. The Traffic Department is in charge of preparing traffic plans and traffic management in case of accidents and operating traffic wardens. It is responsible for receiving, investigating and surveying accidents. The Traffic Engineering Unit in the Traffic Department is responsible for technical works relating to roads and vehicles. This unit's tasks include: coordinating with other governmental bodies in relation to traffic engineering, i.e. municipalities, installing and maintaining traffic signs, and proposing and supervising the installation, operation, and maintenance of traffic lights (Ministry of Interior, 2001).

4.2.4 Ministry of Education

This Ministry is responsible for the systems of education up to the high school level. Schools in Saudi Arabia are segregated according to gender, so boys' schools are separated from girls' ones. Pupils begin school in Saudi Arabia when they are six years old. Previously, the authority bodies were two: the Ministry of Education for Boys' schools and the General Presidency of Girls' Education. This situation prevailed until 24-3-2002 when the General Presidency of Girls' Education was merged with the Ministry of Education. The General Presidency of Girls' Education before merger was committed to providing bus services to female intermediate and high school students, although the capacity of the buses and the services provided were insignificant in number to meet the needs of schools served. The Ministry of Education was not involved in providing school buses for children to boys' schools. Recently, the Ministry has introduced a pilot study in Riyadh in cooperation with the SAPTCO, with the aim of providing transport to and from boys' schools. (Al-Mahraj and Assadhan, 1998)

4.2.5 Compatibility between transport authorities

It can be seen from the above that the transportation system responsibilities of planning, supervision and management are implemented by different bodies. The

existence of many bodies proposing and developing transport policies makes coordination and harmony between them a difficult task due to differences in authorities' goals and policies (ADA, 1997, p. 7).

Lack of coordination between these authorities and the diversity of transport activities led to calls for an independent body, the "Urban Transport Authority", to take full responsibility for planning and implementing urban transportation policies in Saudi cities (ADA, 2000).

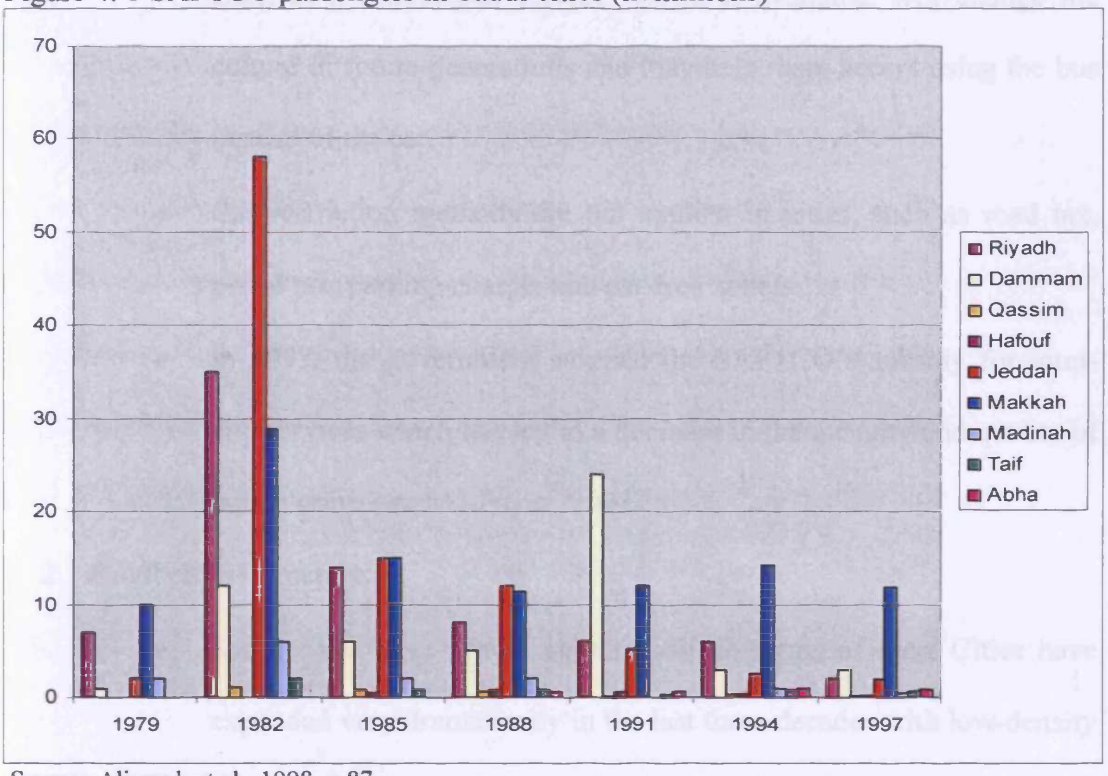
4.3 Critical issues in urban transportation

4.3.1 Public transport in Saudi Arabia

A public transport service had existed in many cities from the 1950s onwards but had served only a few districts and the size of the operation was limited. Independent individual owners or drivers had operated the buses. There were no fixed routes and operators changed the routes from time to time in response to demand (Abdulaal, 1992)

In 1979, the Saudi Arabian Public Transport Company (SAPTCO) was established, and was regarded as the first conventional public transport service in the country. The Deputy for Transport Affairs in the Ministry of Communication initially controlled and supervised the operation, level of services, price and subsidy to the SAPTCO. Eventually, the SAPTCO obtained a monopoly contract for providing public transport services in all Saudi cities. The government guarantees to render an annual profit to shareholders. The company runs its intra-city services in 9 cities with route networks varying from just one service in Abha to 22 in Makkah. Figure 4.1 shows the number of SAPTCO passengers in Saudi cities (in millions).

Figure 4. 1 SAPTCO passengers in Saudi cities (in millions)



Source: Aljomah et al., 1998, p.87.

Dramatic decrease is noted regarding the number of passengers due to different reasons:

1. Socio-economic factors:
    - Public transport started operating in Saudi cities at a time of economic development which led to an increase in individual incomes so the ordinary man in the street can easily buy a car. In fact, Saudi households have one of the highest car ownership rates in the world, 1.52 cars per household. (ADA,1997).
    - The public transport service is associated with low-income foreign workers and this may affect the use of it by Saudi middle class groups.
    - Ordinary people do not have the experience of taking a bus, so they may suspect the quality of the service.

- Lack of a school bus service which, if available, will change the culture of future generations and may help them accept using the bus instead of the car.
- Car restriction methods are not applied in cities, such as road tax, petrol tax, parking charge, and car-free zones.
- In 1997, the government stopped the SAPTCO's subsidy for intra-city services which has led to a decrease in the quantity and quality of public transport. (Al-Fayez, 2001)

2. Saudi cities' structure:
    - Saudi cities have grown very rapidly in terms of area. Cities have expanded very dramatically in the last three decades with low-density land subdivision, which increases the demand for route networks expansion but generates fewer numbers of passengers.
    - Road and neighbourhood designers do not provide for public transport needs in their proposed designs, i.e. bus stops, bus bays, and bus stations.
    - No priority has been given to public buses on major roads which increases the trip time and trip cost.

All these factors have negatively influenced the quality of services provided by the SAPTCO and forced it to change its strategy to focus on profitable services, i.e. inter-city and international route services.

4.3.2 School Transport

The school service is a substantial service in a country where 46.2 % of its population are under 15 years old (Central Department of Statistics, 1999). Government spending has set aside a major amount of its budget for the education

sector due to its strategic importance to the country's future and human resources development.

The increase in school numbers and student figures has generated a demand on school transport which unfortunately has not received the necessary attention. The boys' school authority in the Ministry of Education provides school transport only for students in villages or rural areas who live far away from schools. It is not involved in urban school transport provision. The Girls' Education Authority, before merging with the Ministry of Education in 2002, was committed to providing school transport in urban areas. But due to the same funding difficulties, it could not cope with the high demand. For example, in Jeddah the percentage of girls served by school transport was 15% (Alrasheed, 1988), and in Riyadh the percentage was 18% (Almoteer et al., 1999).

The lack of government provided school transport has social, economic and environmental implications:

- The household head loses time and money participating in escorting children to and from school.
- There are national economic losses as employees leave their workplaces in working hours to take children to and from school.
- The need to recruit a chauffeur by households to take care of school trips, means extra economic cost as well as social costs, as this chauffeur will have to live with the family in the same house in most cases.

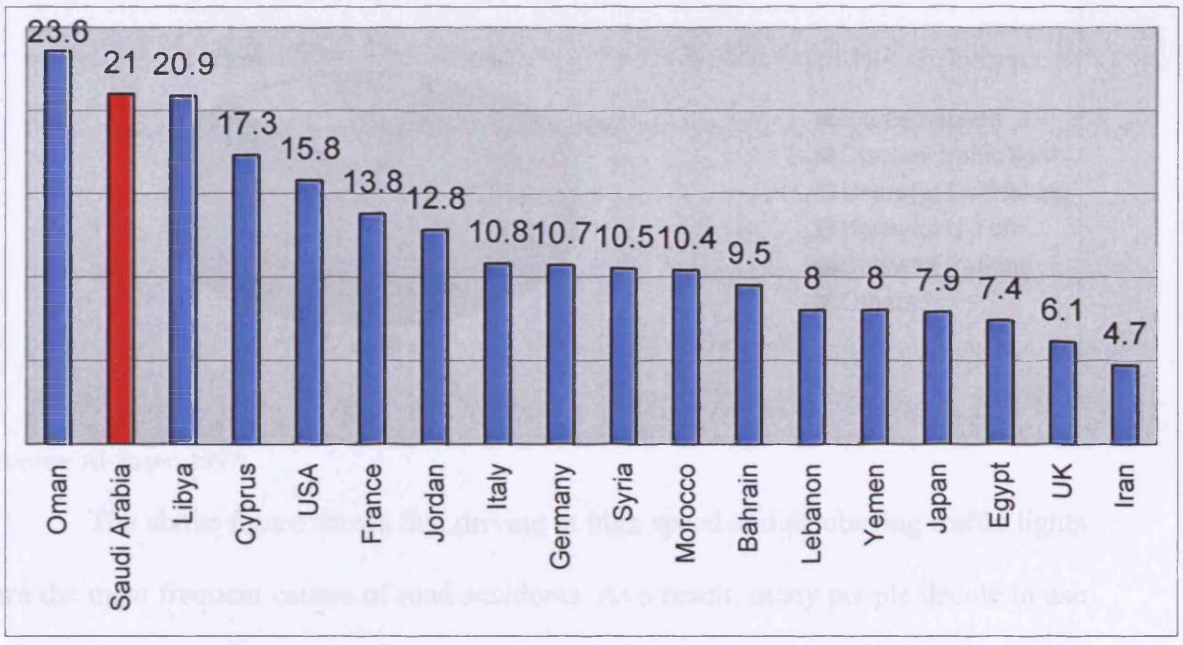
4.3.3 Traffic Accidents in Saudi Arabia

Road deaths appear to be a growing problem worldwide. The international community is very concerned about the number of people killed each year. In Saudi

Arabia, road crashes have grown faster than the population, in fact, 40 per cent faster (Jacobs et al., 2000).

Saudi Arabia has one of the highest fatality rates. Figure 4.2 shows that Saudi Arabian has the highest fatality risk within the Middle East and North Africa regions and also compared to developed countries.

Figure 4. 2 Accidents Deaths per 100.000



Source: Jacobs et al., 2000.

A recent report on traffic safety in Riyadh stated:

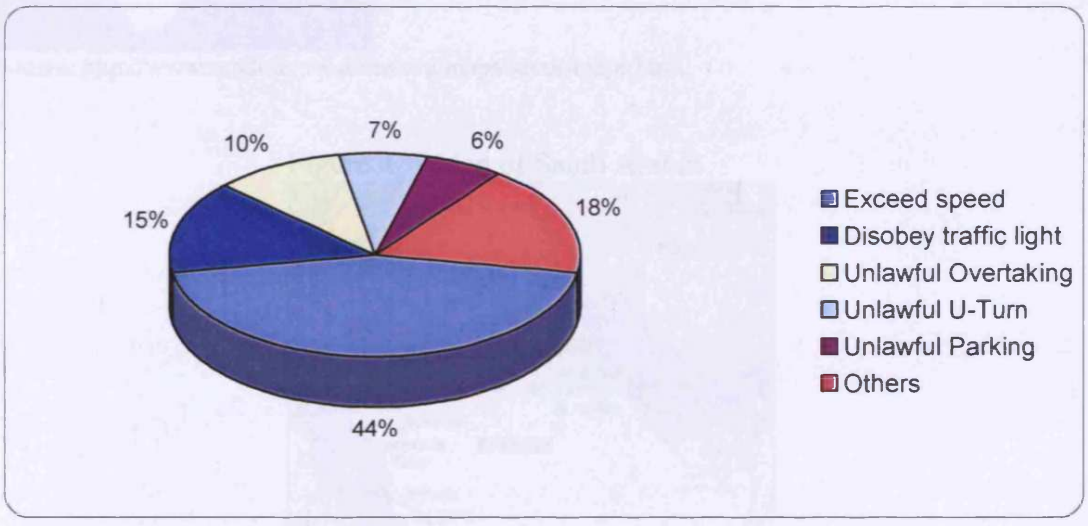
> "*Statistics show that about 300 thousand road crashes yearly lead to 4000 deaths and more than 30,000 injuries. If the international definition of road crash deaths is applied (any person who is killed outright or who dies within 30 days as a result of an accident) the number of deaths may reach 8000 persons. About 2000 people who are injured end up with a disability. 30% of hospital beds are occupied by accident causalities. The national economy loses about 21 billion Saudi Riyals annually owing to the cost of road crashes*" (TRL, 2003).

These figures illustrate the lack of traffic safety in Saudi Arabia. This record of traffic accidents might encourage the public to shift to public transport if a high quality service with a high safety profile could be achieved.

4.3.4 Traffic Offences

Traffic offences are the main reason for road crashes (Abdulaal, 2001). The number of offences reported by traffic police was about 8 million in 2003, which are two offences per driver. Figure 4.3 shows the most common causes of road accidents.

Figure 4. 3 Road Accident Causes



Source: Al-Saqer, 1997.

The above figure shows that driving at high speed and disobeying traffic lights are the most frequent causes of road accidents. As a result, many people decide to use the car instead of walking because they are afraid of the risk of crossing roads.

4.4 Dammam city: Location and Function

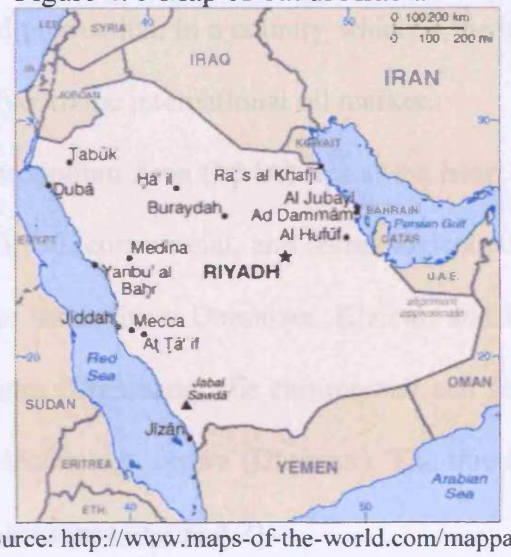
Dammam is important as part of an axis of national development and because of its function as a centre for the oil industry (see Figure 4.4). Saudi Arabia's economy is classified as an oil-based economy, which accounts for roughly 75% of budget revenues, 45% of GDP, and 90% of export earnings (Ministry of Planning, 2000).

Dammam is the administrative capital of the Eastern province in Saudi Arabia (see Figure 4.5). The Eastern province is the largest administrative region in Saudi Arabia, forming 25% of the total area of the kingdom (Figure 4.6). The Eastern

Figure 4. 4 Saudi Arabia's location

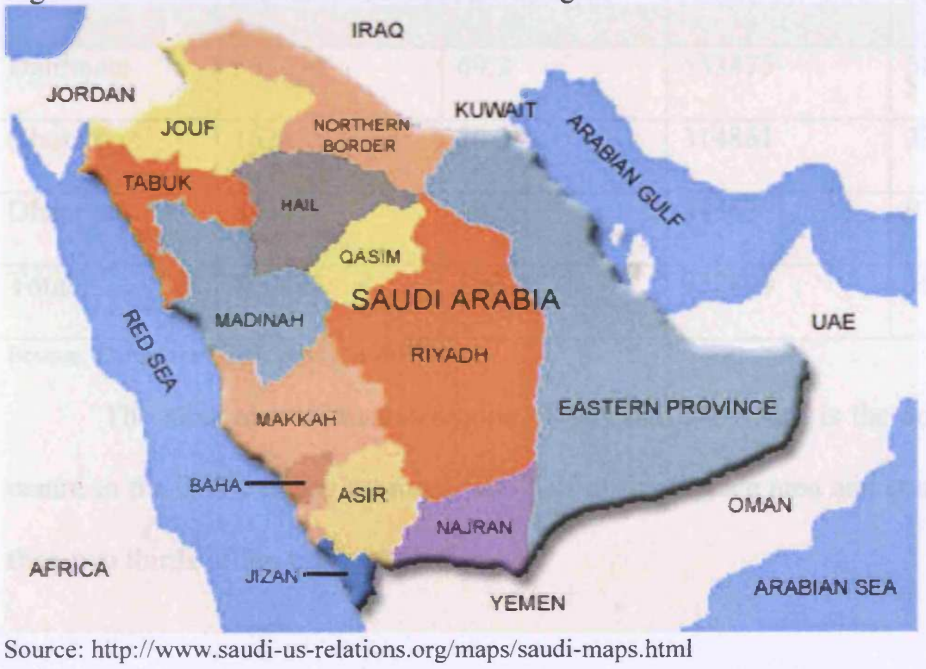
Source: http://www.saudi-us-relations.org/maps/saudi-maps.html

Figure 4. 5 Map of Saudi Arabia



Source: http://www.maps-of-the-world.com/mappages/Saudi_Arabia_map.htm

Figure 4. 6 Saudi Arabia's administrative regions



Source: http://www.saudi-us-relations.org/maps/saudi-maps.html

province derives great advantage from its location, bordered on the east by the Arabian Gulf and five Gulf countries: Kuwait, Bahrain, Qatar, UAE, and Oman. This location gives the province significant regional importance due to it being the eastern "gateway" for the kingdom's imports and exports. The province works as a link between all Gulf countries, i.e. a person who is travelling inland from one country to another needs to go through the eastern province. The region has the largest oil reserves in the world, which gives the province international recognition as a centre for oil exploration and production, in a country which is the largest oil exporter in the world and a major player in the international oil market.

Dammam Metropolitan Area (DMA) lies at the heart of the Eastern province, since the region's political, commercial, and technological activities are concentrated here. DMA consists of three cities: Dammam, Khobar, and Dhahran. DMA contains the administrative centre (Dammam), the commercial and financial centre (Khobar), and the research and technology centre (Dhahran). The three cities now form almost one continuous urban area (see Figure 4.7).

Table 4. 1 The characteristics of cities forming DMA

City	Population	%	Area	%
Dammam	553474	69.2	553475	58
Khobar	162585	20.3	314861	33
Dhahran	84062	10.5	84563	9
Total	800121	100	952899	100

Source: Dammam Municipality, 1997.

The table above illustrates quite clearly that Dammam is the dominant urban centre in the DMA taking up more than half of the surface area and comprising more than two thirds of the total population.

Figure 4. 7 Dammam Metropolitan Area

Source: http://www.easternemara.gov.sa/map-sharg8.htm

As a result of its importance at the national and regional level, Dammam accommodates all regional governmental bodies which provide facilities for the region's population. The most important governmental bodies include:

- The Emarah (the Eastern Province's governing body): the body in charge of politics, security, and controlling smaller administrative sectors in the eastern region (Muhafadah).
- Dammam Municipality: the body responsible for the planning and management of the physical environment in DMA
- King Abdul Aziz Seaport: the second port in Saudi Arabia in terms of goods handling. The port has been developed to receive imported goods and export local products around the world.
- Industrial Districts: Dammam has two industrial districts which contain more than 500 productive factories in different sectors, including food, paper and plastics, electronics, building materials, and chemical industries.

4.5 Natural environment

The Dammam area can be described as flat, except around Dhahran hill. Its mainly flat surface is conducive to pedestrian activities in the Dammam area. The climate in the Dammam area is hot and humid in summer, and cold and dry in winter. The highest temperature period is between May and August, when the temperature reaches 42 degrees centigrade. In winter, between October and April, the temperature is 7 degrees centigrade or less. Humidity is high and ranges between 50%-75% because of the Arabian Gulf influence. This weather influences people's choice of travel modes. In summer, when temperatures reach more than 42 degrees centigrade and humidity is high, up to 75%, most people exclude the walking option, even for short trips, i.e. to shops and mosques.

4.6 Population Growth:

Dammam began when some families from the Al-Doaser tribe came from Bahrain to Dammam and formed a small village dependent upon fishing and pearl collection. Until 1934, the population was approximately 1,350 persons (CH2 Mhill International, 1979, p.292). As a result of oil exploration, in 1933, the need for workers increased which led to an increase of immigrants to Dammam. By 1953, the administrative capital of the eastern province had been transferred from Alhasa to Dammam. This led to the strengthening importance of Dammam as a national city, both politically and economically as the centre of oil exploration and production.

Dammam attracts a huge number of immigrants, both national and international. This has led to a rapid growth in Dammam's population in a short period. Table 4.2 shows just how quickly its population has increased. The Dammam Structural Plan Study (1976) estimated an annual population growth of 4.79% and predicted a population of 175,000 inhabitants by 1995. The population census results in 1992 show that, in fact, Dammam's population exceeded 480,000 inhabitants. Population growth is due mainly to three factors:

1. National labour immigration, that is, immigrants from other regions of Saudi Arabia who have moved to Dammam looking for better job opportunities.
2. International labour immigration. Due to a lack of trained and qualified manpower, Saudi Arabia welcomed foreign workers to work in development projects, and the oil industry was one of the most attractive.
3. Natural population growth. As a result of Islamic regulations, which encourage families to have as many children as they can, the average Saudi family has one of the highest fertility rates in the world, 7.5 persons/household (ADA,1998).

Table 4. 2 Population growth of Dammam

Year	Population	Source
1934	1350	Estimation(1)
1952	25,000	Estimation(2)
1974	125,335	1974 Population Census
1992	482,321	1992 Population Census

(1),(2): CH2 Mhill International, 1979, p.292

4.7 Urban Development in Dammam:

In a short period of time, Dammam has grown from a small village to become the fifth city in Saudi Arabia in terms of population (Central Department of Statistics, 1993). To accommodate such population growth, land demand is very high. The city has expanded through:

1. Horizontal growth: the city grew to the east by filling in the coastal area and extending towards vacant land in the west and south west.
2. Vertical development. The CBD was redeveloped in the 1980s with high buildings and a change in zoning in some areas to accommodate more residential units, and also by developing a high-density housing project which accommodated 1664 flats.

Table 4.3 shows the rapid increase in the urban area of Dammam city since 1960. As can be seen, Dammam's area has increased by 11 times within 25 years (see Figures 4.8 and 4.9). Due to the absence of a local authority responsible for urban planning development, the Saudi ARAMCO oil company (an American company until the 1970s when it became a Saudi Arabian oil company), was a major player in Dammam's urban development in the 1950s and 1960s. Aramco developed its own land subdivision in Dammam and Alkhobar, to accommodate the company's employees. Old land subdivisions form the city centre of Dammam today and these are easily recognisable because of the grid street system design.

Table 4. 3 Development of Dammam Urban area

Year	Area (Hac.)
1934	300
1960	700
1969	2200
1980	4500
1985	8200
1997	11623

Source: Dammam Municipality, 1997.

4.8 Dammam neighbourhoods:

According to the population census results (1993), Dammam city consists of 29 sub-areas, 8 of which can be classified as industrial or services areas. Unfortunately, the census does not provide a map showing neighbourhood boundaries. Population census officials claimed, during field trip interviews, that they used a Dammam Municipality map. However, the researcher found it difficult to discover which map was used because there are several old and new maps of Dammam. The present study uses the new map proposed by Dammam Municipality which clearly defines neighbourhoods and their boundaries. The total population of Dammam was 482,321 persons. The population was distributed among 21 residential neighbourhoods. Table 4.4 shows the population of neighbourhoods in 1993.

Figure 4. 8 Dammam city in 1950

Source:httpwww.easternemara.gov.sa/shargiahpicture.html

Figure 4. 9 Dammam city in 1975.

Source: http://www.easternemara.gov.sa/shargiahpicture.html

Table 4. 4 Dammam Neighbourhood characteristics*.

Neighbourhood Name	Population[1]	Residential Unit[2]	Area in hac.[3]	Density (person/hac)	Residential unit/Hac
Addamah	32,089	7132	320	100	22
Doasser and part of Amamerah	18,453	4095	57	324	72
Ammamrah	6,994	1183	38	184	31
Naseem	6,871	953	84	81	11
Khaleej	20,797	3895	102	203	38
Nakhel and Qazaz	24,746	4959	130	190	38
Badyah	33,060	5830	145	228	40
75	21,935	3375	194	113	17
8	18,505	2716	73	253	37
Jalawiah	31,802	5277	144	220	37
Aziziah	8,318	1198	118	70	10
71	20,972	2817	83	252	34
91	23,132	3060	90	257	34
37 and 77	14,564	2107	176	82	12
Itsallat	12,220	1628	56	218	29
Alomal	27,090	4283	341	79	13
Abdullah Foad	23,351	2983	146	160	20
National Guard	17,640	1996	85	207	23
Petromin	21,514	2229	132	163	17
Altobaishi	19,428	4205	314	62	13
Prince Talal	12,417	2271	90	138	25

* Name and boundary partly different from the seven neighbourhoods used in the study.
Sources: 1,2) Central Department of Statistics,1993.
3) Dahaish, 2000.

4.9 Selected Neighbourhoods' Characteristics

The study selected seven neighbourhoods in Dammam as case studies representing the characteristics of Dammam neighbourhoods. The selected neighbourhoods were: Al-Khaleej, Iscan "Housing project", Aziziah, Gharnatah,

Roabi, Petromin, and Jameyyan (see Figure 4.10). Neighbourhoods were selected based on four criteria: first, population density: the selected neighbourhoods presented different population densities; high, middle and low. Second, neighbourhood design: Dammam's neighbourhoods vary in design: grid-iron, irregular grid system, and dead-end road network. Third, distribution of services: services' location is an important factor when studying accessibility to services. Distribution of services can take the form of different patterns in neighbourhoods: hierarchical, central or random distribution. Finally, residents' income: each neighbourhood differs in terms of income: high, middle, or low. The following section explores the physical and socio-economic characteristics of selected neighbourhoods.

4.9.1 Physical characteristics of the sampled neighbourhoods

4.9.1.1 Population density

One of the study objectives is to examine the impact of neighbourhoods' characteristics on travel behaviour. Population density has been found in the literature review to be a significant variable in travel behaviour (see, for example, Newman and Kenworthy, 1996; Banister, 1999; Ortuzar and Willumsen, 2001). The Dammam Master Plan (1975) proposed three types of residential density in the Dammam area: low density: 50 persons/hectare or less, mid-density: 150 persons/hectare; and high density: 250 persons /hectare or more (Dammam Municipality, 1992)

From Table 4.5, it can be seen that the selected neighbourhoods have different population densities. The lowest density level is in Jameyyan, recorded as 36 persons/hectare.

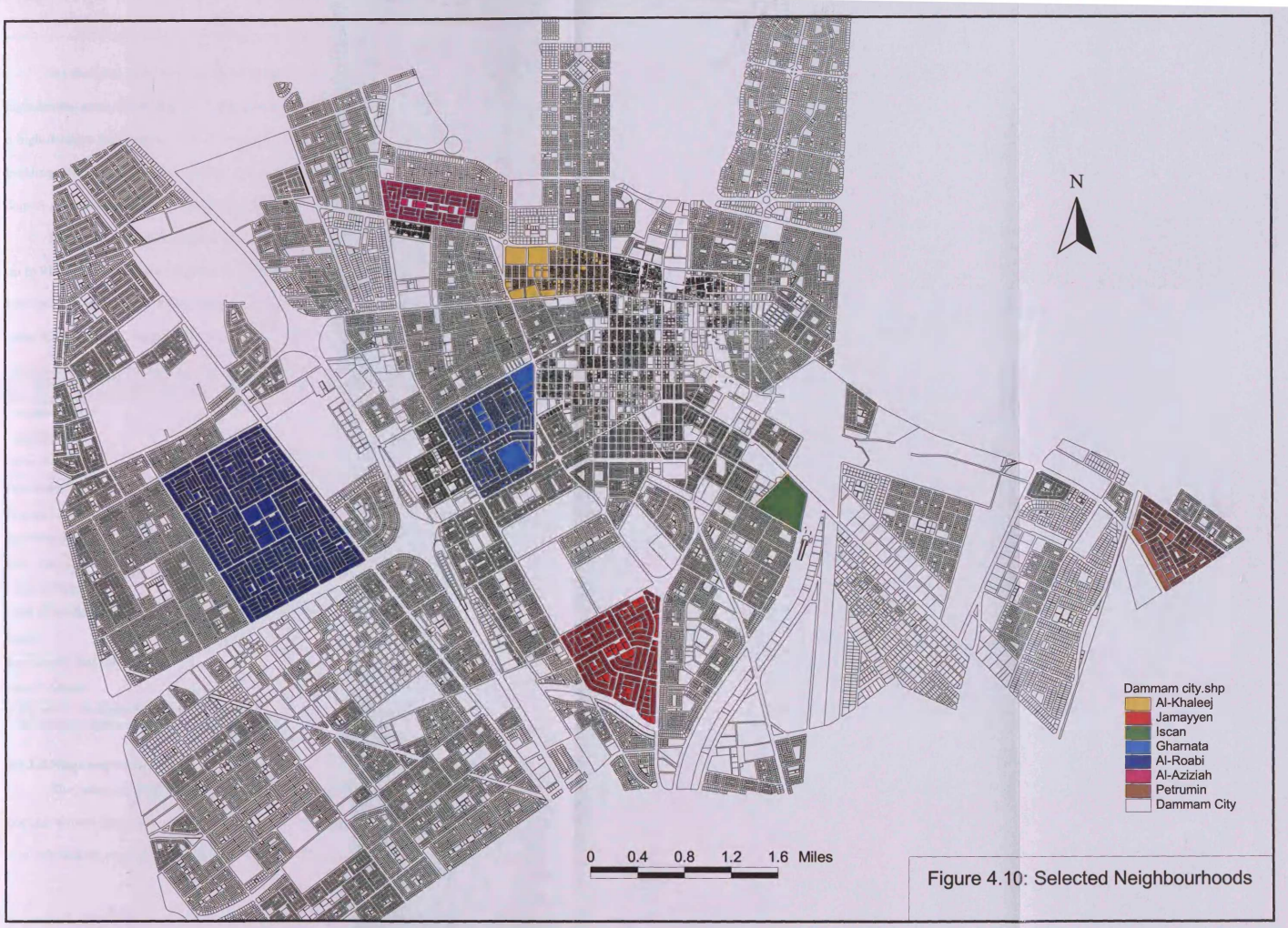


Figure 4.10: Selected Neighbourhoods

On the other hand, the density of Iscan, which was designed to accommodate high-density units, is 294 per/hac. Khaleej, one of the oldest neighbourhoods, also has a high-density: 266 per/hac., due to its small parcel area and because the majority of buildings in it are apartment buildings. The table shows that all the different types of density are represented in the selected neighbourhoods.

Further, the neighbourhoods vary in the area of a parcel of land (from 205 m^2 up to 911 m^2). In addition, neighbourhoods vary in terms of the number of residential units built in each parcel. Iscan consists of 32 tower blocks each having 52 residential units. Khaleej has 3.2 units/parcel, while Jameyyan has 1.1 units/parcel.

Table 4. 5 Population density in selected neighbourhoods[1]

	Khaleej	Jameyyan	Iscan	Gharnatah	Roabi	Aziziah	Petromin
Neighbourhood Area (hectare)	92	179	34	169	390	77	81
No of Res. Unit	4081	1060	1664	4790	5725	1653	824
Population[(2)]	24486	6360	9984	28740	34350	9918	4944
Population Density (pop/hectare)	266	36	294	170	88	129	61
Res. Unit density (unit/ hectare)	44	6	48	28	15	21	10
Area of residential Parcel	221	911	205	462	622	608	637
Residential unit per parcel (Mean)	3.2	1.1	52	3.2	2.3	3	1.8

1- Figures are not comparable with Table 4.5 because of different boundaries and names.
2- Population is calculated by (no. of residential units x Average household size = 6)

4.9.1.2 Neighbourhood Design:

The selected neighbourhoods vary in terms of design. The Grid system is popular within Dammam neighbourhoods. As can be seen from Table 4.6, Khaleej was selected to represent the grid-iron type. Iscan was designed with a "dead-end"

road network to serve each group of buildings. The remaining neighbourhoods have an irregular grid system.

Table 4. 6 Neighbourhoods' design pattern

Neighbourhood	Grid	Irregular grid	Cul-del-Sac	Pedestrian oriented	Road network length (meter/hectare)
Khaleej	√				244
Jameyyan		√			165
Iscan			√	√	111
Gharnatah		√			197
Roabi		√			235
Aziziah		√			199
Petromin		√			226

This table shows that only Iscan can be classified as a pedestrian-oriented neighbourhood since it provides a pedestrian path through the neighbourhood away from the road network.

Road length varies according to neighbourhood characteristics such as design pattern and parcel size. Planners seek to minimise the road length within neighbourhoods to reduce the distance travelled by car and to encourage the design of more pedestrian-oriented neighbourhoods. In Khaleej, where the neighbourhood has a typical grid system, road length per area is the highest of all seven neighbourhoods. (see Figures 4.11, 4.12, and 4.13)

4.9.1.3 Distribution of services:

Dammam neighbourhoods vary in the way public services (i.e. mosques, schools, shops, etc.) are distributed. Service location influences residents' decision to walk or drive to reach that service.

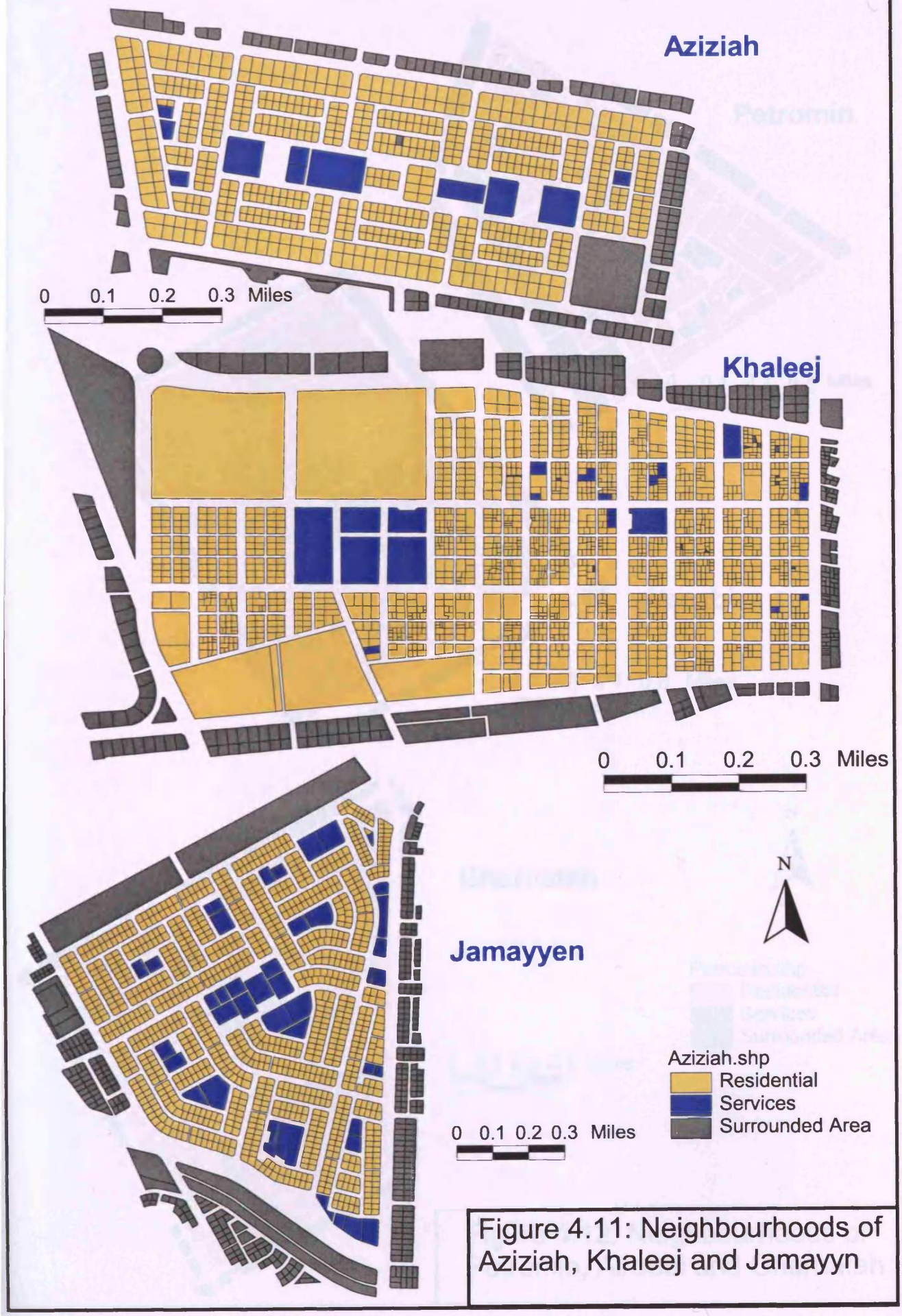


Figure 4.11: Neighbourhoods of Aziziah, Khaleej and Jamayyn

Source: Compiled by the author.

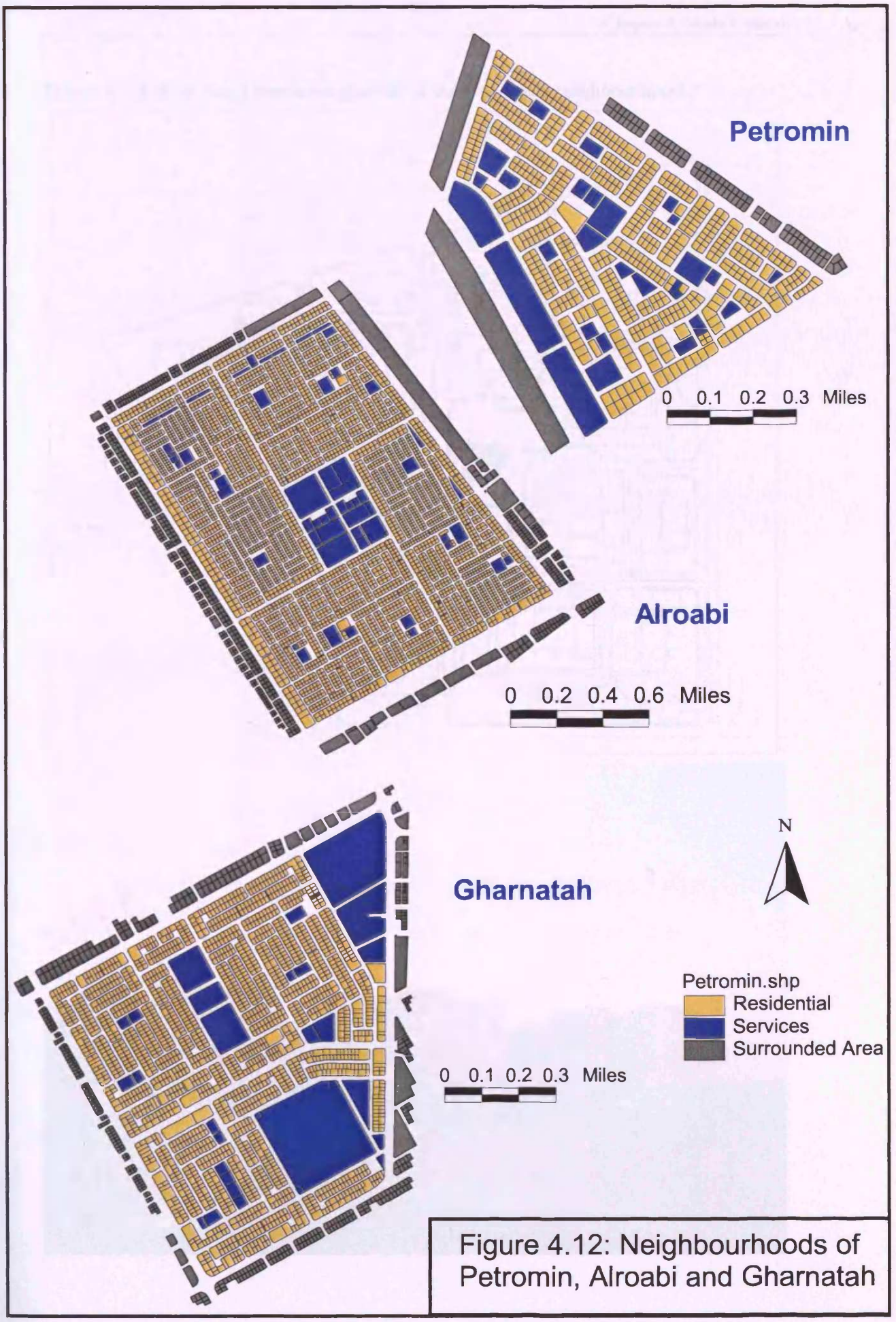


Figure 4.12: Neighbourhoods of Petromin, Alroabi and Gharnatah

Source: Compiled by the author.

Figure 4. 13 Iscan neighbourhood plan and a view to Isacn neighbourhood

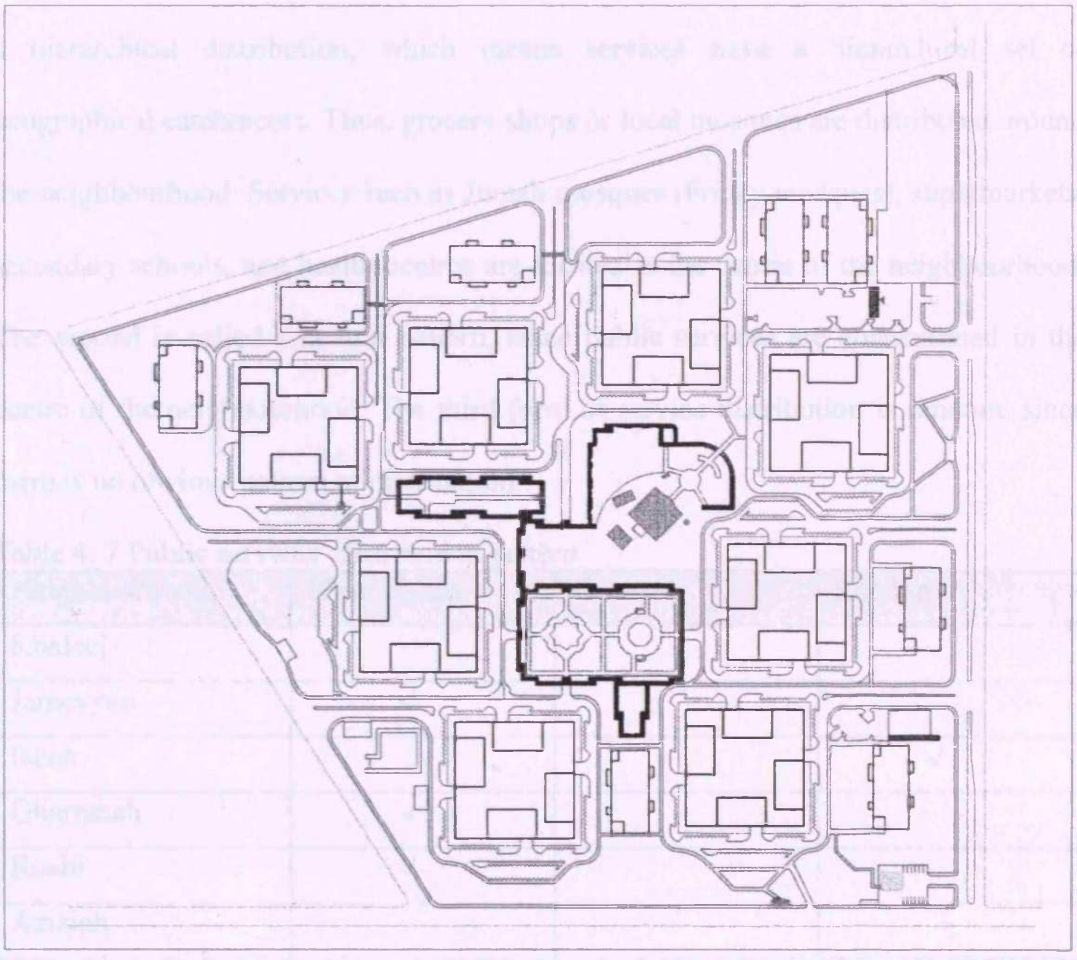


Table 4.7 shows three distribution patterns of services. The first pattern shows a hierarchical distribution, which means services have a hierarchical set of geographical catchments. Thus, grocery shops or local mosques are distributed around the neighbourhood. Services such as Jumah mosques (Friday mosques), supermarkets, secondary schools, and health centres are located in the centre of the neighbourhood. The second is called a central pattern, since public services are concentrated in the centre of the neighbourhood. The third form of service distribution is random, since there is no obvious pattern of distribution.

Table 4. 7 Public services' distribution pattern

Neighbourhood	Hierarchical	Central	Random
Khaleej			√
Jameyyan	√		
Iscan			√
Gharnatah	√		
Roabi	√		
Aziziah		√	
Petromin	√		

4.9.1.4 Land Use characteristics

Residential use is the majority land use in the selected neighbourhoods. Table 4.8 presents land uses in selected neighbourhoods. Because Khaleej is an old district, there is a mix of commercial and residential use, residential use is nearly third of the neighbourhood's area (31 to 34 %). In Iscan, tower blocks are built up to 17 floors, and the built up area covers 38%. Residential use constitutes more than 50 % of other neighbourhoods' area.

The land development process in Saudi Arabia gives the land owner the right to develop the land when and however he chooses. Table 4.8 shows that between 31% to 33% of residential land is left undeveloped in Khaleej, Roabi, and Petromin.

However, in Jameyyan, Gharnatah, and Azizah, the percentage of residential land left undeveloped is 16%, 21% and 24%, respectively (see Figures 4.14 and 4.15).

Table 4. 8 Land uses of selected neighbourhoods

Land Use	Khaleej	Jameyyan	Iscan	Gharnatah	Roabi	Aziziah	Petromin
% of residential uses	34	56	23	42	56	53	52
% of vacant land	32	16	0	21	33	24	31
% of commercial use	14	1	4	2	2	4	1

Source: Compiled by the author using GIS data.

4.9.1.5 Distance to the CBD

Distance to the CBD is an indicator of ease of accessibility to the city centre where commercial and governmental departments are concentrated. As can be seen from Table 4.9, Khaleej is the nearest neighbourhood (2 km from the CBD), whereas Petromin is the farthest (10.2 km).

Table 4. 9 Distance to the CBD

Neighbourhood	Distance to the CBD (km)
Khaleej	2
Aziziah	3.4
Gharnatah	4.17
Iscan	5.6
Jameyyan	7.5
Roabi	9.64
Petromin	10.23

Source: Compiled by the author using GIS data.

4.9.2 Neighbourhoods' Socio-economic characteristics

This part provides a description of the socio-economic characteristics of sampled households in the selected neighbourhoods. One objective of the study is to explore the influence of socio-economic characteristics on travel behaviour. This section presents a comparison between neighbourhoods' socio-economic attributes.

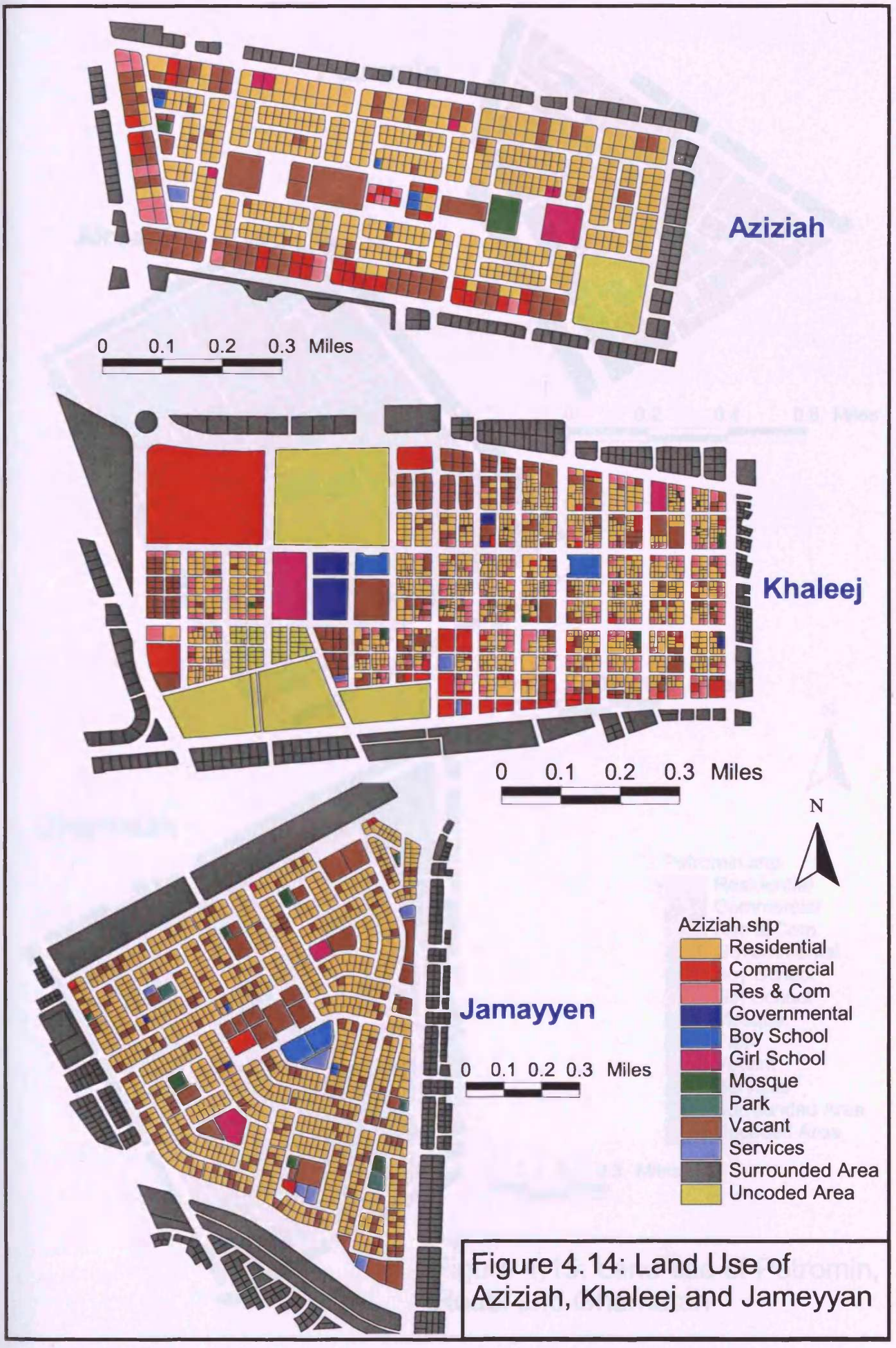


Figure 4.14: Land Use of Aziziah, Khaleej and Jameyyan

Source: Compiled by the author.

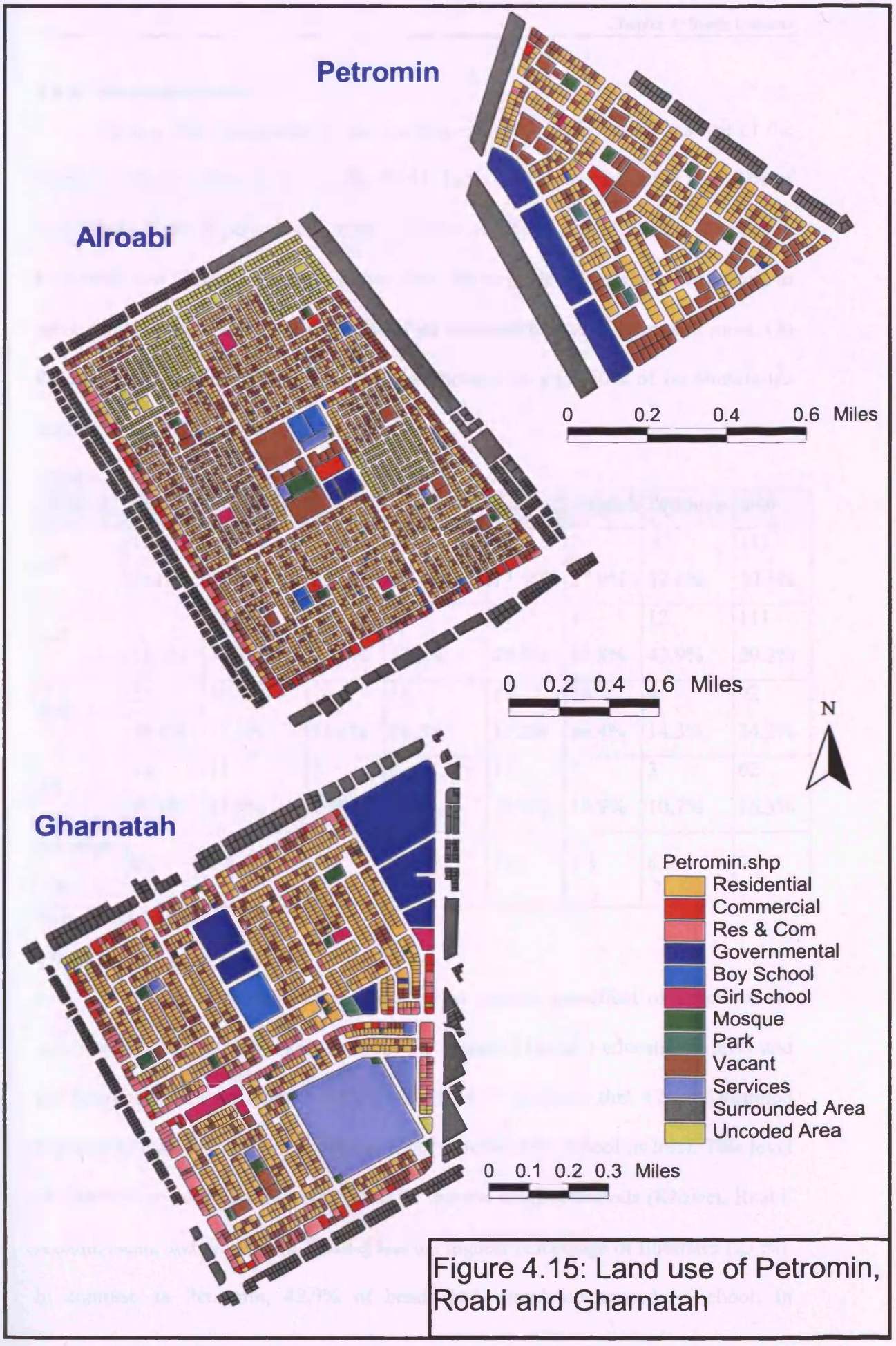


Figure 4.15: Land use of Petromin, Roabi and Gharnatah

Source: Compiled by the author.

4.9.2.1 Household size

As has been mentioned in the previous section, Saudi Arabia has one of the highest average household sizes in the world. Table 4.10 shows that more than 40% of households have 8 persons or more in them. Neighbourhoods differ slightly in household size. The Khaleej area, a poor area, has larger household sizes compared to other neighbourhoods, since about 65% of its households have 8 persons or more. On the other hand, Ghurnatah has the smallest household size, 50% of its households have between 2-5 members.

Table 4. 10 Household size

Size	Khaleej	Jameyyan	Iscan	Gharnatah	Roabi	Aziziah	Petromin	total
2-5	15 24.6%	16 23.2%	24 38.1%	28 49.1%	16 27.5%	7 15.9%	9 32.1%	115 30.3%
6-7	7 11.5%	23 33.3%	27 42.9%	11 19.3%	17 29.3%	14 31.8%	12 42.9%	111 29.2%
8-9	21 34.4%	19 27.5%	7 11.1%	15 26.3%	10 17.2%	16 36.4%	4 14.3%	92 24.2%
10 +	18 29.5%	11 15.9%	5 7.9%	3 5.3%	15 25.9%	7 15.9%	3 10.7%	62 16.3%
Average size	8.2	7.3	6.2	5.9	7.4	7.8	6.5	7.1

Source: Household survey, 2003.

4.9.2.2 Educational level

The study uses the educational level to explore the effect of education on travel behaviour. Is there a link between the household head's educational level and the household's travel activity pattern? Table 4.11 indicates that 42% of sampled household heads had a low educational level (intermediate school or less). This level of education is common in low and middle income neighbourhoods (Khaleej, Roabi, Azizah, Iscan, and Gharnath). Khaleej has the highest percentage of Illiterates (23 %). In contrast, in Petromin, 42.9% of heads had completed secondary school. In

Jameyyan, a high-income area, the majority of its residents were university graduates (43.5 %).

Table 4. 11 Household heads' educational level

Educational Level	Khaleej	Jameyyan	Iscan	Gharn-atah	Roabi	Aziziah	Petromin	total
Illiterate	14 23.0 %	1 1.4 %	1 1.6 %	2 1.6 %	2 3.5 %	3 5.2 %	3 6.8 %	26 6.9 %
Low	35 57.4 %	15 21.7 %	28 44.4 %	24 42.1 %	28 48.3 %	21 47.7 %	11 39.3 %	162 42.6 %
Middle	11 18.0 %	23 33.3 %	23 36.5 %	17 29.8 %	14 24.1 %	14 31.8 %	12 42.9 %	114 30.0 %
High	1 1.6 %	30 43.5 %	11 17.5 %	14 24.6 %	13 22.4 %	6 13.6 %	3 10.7 %	78 20.5
Total	61 100 %	69 100 %	63 100 %	57 100 %	58 100 %	44 100 %	28 100 %	380 100 %

Source: Household survey, 2003.

4.9.2.3 Occupation

Occupation is an important variable affecting household heads' activities. Each occupation has its own characteristics (i.e. type of work, working hours, social prestige, and income). Thus, occupation may have an influence on the household's travel behaviour. The majority of households depend on the household head as the main breadwinner. Thus, the household head's occupational characteristics will impact on the household situation in most cases.

Table 4.12 shows that the majority of heads are professionals, nearly 40%, while 23% of heads work in administrative jobs. When comparing occupations in selected neighbourhoods, it can be seen that the highest number of blue-collar workers is in the Khaleej area (20 %). Jameyyan has the highest percentage of retired heads (36 %). Iscan and Gharnatah have high numbers of professionals (34% and

42%, respectively). The majority of heads in Aziziah and Petromin work in the administrative sectors (57% and 49%, respectively).

Table 4. 12 Household heads' occupation

Occupation	Khaleej	Jameyyan	Iscan	Ghar-natah	Roabi	Aziziah	Petromin	total
Professional	20 32.8 %	20 29.0 %	36 57.1 %	28 49.1 %	20 34.5 %	13 29.5 %	11 39.3 %	148 38.9 %
Administrative	12 19.7 %	16 23.2 %	12 19.0 %	8 14.0 %	12 20.7 %	15 34.1 %	12 42.9 %	87 22.9 %
Businessman	1 1.6 %	7 10.1 %	2 3.2 %	3 5.3 %	10 17.2 %	5 11.4 %	1 3.6 %	29 7.6 %
Workman/ Blue collar workers	12 19.7 %	0	2 3.2 %	5 8.8 %	3 5.2 %	3 6.8 %	0	25 6.6 %
Retired	8 13.1 %	25 36.2 %	8 12.7 %	9 15.8 %	10 17.2 %	5 11.4 %	2 7.1 %	67 17.6 %
Unemployed	3 4.9 %	0	1 1.6 %	2 3.5 %	0	0	0	6 1.6 %
Other	6 9.8 %	1 1.4 %	2 3.2 %	2 3.5 %	3 5.1 %	3 6.8 %	2 7.1 %	16 4.2 %
Total	61	69	63	57	58	44	28	380

Source: Household survey, 2003.

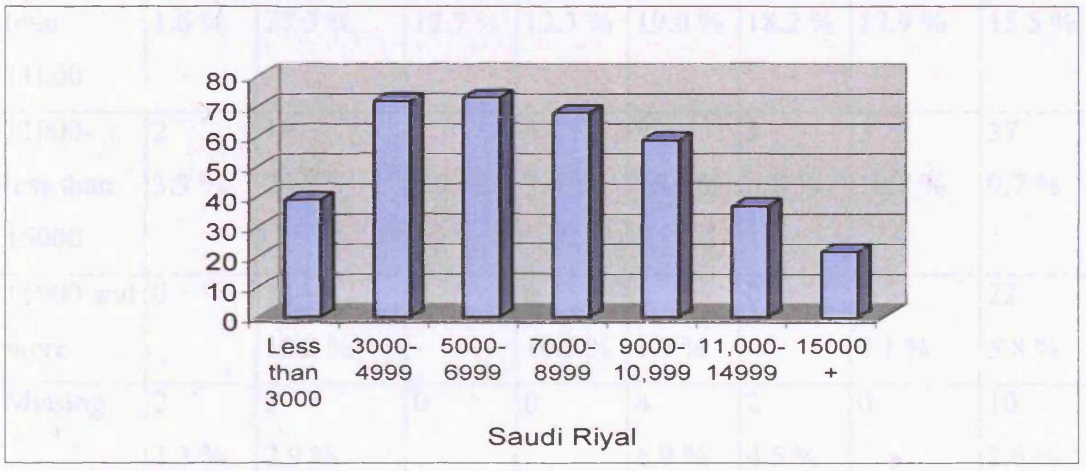
4.9.2.4 Monthly Income

Income is a very common variable used in previous studies of travel behaviour. The literature shows a significant relationship between income and travel behaviour (Ortuzar and Willumsen, 2001). Table 4.13 shows that the sampled households vary in terms of the head's income. Income is separated into seven categories. The research revealed that 10 % of the study population were in the "very low income" group (less than three thousands Saudi Riyal (SR)), and in the "lower-high income" group, (11000 to less than 15000 SR). Nineteen per cent of the study population were in the "low income" group (3000- less than 5000 SR) and in the

"lower-middle income" group (5000-less than 7000 SR). Eighteen per cent of the population earned between 7000 and less than 9000 SR, while sixteen per cent earned between 9000- less than 11000 SR. Finally, 6% of the study population were in the "high income" group and earned 15000 SR or more.

Household heads' income varied between neighbourhoods. Khaleej can be classified as a poor area since 31 % of its population are in the "very low-income" group, and 38 % are in the "low-income" group. On the other hand, Jammeyyan can be classified as a high-income area due to the fact that 39 % of its population are in "high income" groups.

Figure 4. 16 Income by household numbers



Source: Household survey, 2003.

Table 4. 13 Household Heads' Income

Income Category (SR)	Khaleej	Jameyyan	Iscan	Ghar-natah	Roabi	Aziziah	Petromin	Total
Less than 3000	19 31.1 %	1 1.4 %	9 14.3 %	5 8.8 %	1 1.7 %	3 6.8 %	1 3.6 %	39 10.3 %
3000-less than 5000	23 37.7 %	2 2.9 %	10 15.9 %	10 17.5 %	9 15.5 %	12 27.3 %	6 21.4 %	72 18.9 %
5000-less than 7000	10 16.4 %	11 15.9 %	11 17.5 %	15 26.3 %	11 19.0 %	9 20.5 %	6 21.4 %	73 19.2 %
7000-less than 9000	4 6.6 %	7 10.1	23 36.5 %	10 17.5 %	12 20.7 %	7 15.9 %	5 17.9 %	68 17.9 %
9000-less than 11000	1 1.6 %	19 27.5 %	8 12.7 %	7 12.3 %	11 19.0 %	8 18.2 %	5 17.9 %	59 15.5 %
11000-less than 15000	2 3.3 %	14 20.3	2 3.2 %	4 7.0 %	9 15.5 %	3 6.8 %	3 10.7 %	37 9.7 %
15000 and more	0	13 18.8 %	0	6 10.5 %	1 1.7 %	0	2 7.1 %	22 5.8 %
Missing	2 3.3 %	2 2.9 %	0	0	4 6.9 %	2 4.5 %	0	10 2.6 %
Total	61 100 %	69 100 %	63 100 %	57 100 %	58 100 %	44 100 %	28 100 %	380 100 %

(1 US Dollar = 3.75 SR) Source: Household survey, 2003.

4.9.2.5 Car ownership:

Car ownership is a very important variable in travel behaviour studies, especially in communities where the car is the dominant travel mode. Table 4.14 shows that only 2 % of households had no car. On the other hand, nearly 60 % of households had two cars or more. In the Khaleej and Iscan areas, 57% and 60% of households owned one car only, respectively. Jameyyan had the highest level of car ownership, more than 55 % of its households had three cars or more.

Table 4. 14 Car ownership

Car number	Khaleej	Jameyyan	Iscan	Gharn-atah	Roabi	Aziziah	Petromin	total
0	4 6.6 %	0	1 1.6 %	1 1.8 %	1 1.7 %	0	0	7 1.8 %
1	35 57.4 %	7 10.1 %	39 61.9 %	24 42.1 %	16 27.6 %	17 38.6 %	12 42.9 %	150 39.5 %
2	14 23.0 %	24 34.8 %	14 22.2 %	17 29.8 %	23 39.7 %	16 36.4 %	11 39.3 %	119 31.3 %
3 and more	8 13.1 %	38 55.1 %	9 14.3 %	15 26.3 %	18 31.0 %	27 25.0 %	5 17.9 %	104 27.4 %
Total	61 100 %	69 100 %	63 100 %	57 100 %	58 100 %	44 100 %	28 100 %	380 100 %

Source: Household survey, 2003.

4.10 Dammam Urban Transportation:

Dammam is a city well served by a modern road network. Dammam can be classified as a car-oriented city due to it is urban development, high car ownership and lack of public transport. There are different modes of public transport in Dammam: Public buses, private mini-buses, taxis, limousines and school transport buses.

4.10.1 Public Buses

There are two types of bus services in Dammam. The first is operated by the Saudi Arabian Public Transport Company (SAPTCO). The second is called Coaster, is run by individuals and operates at peak hours on selected profitable routes. The SAPTCO is partly owned by the government which provided a guaranteed profit of 15%, later reduced to 7%. The government aims, by subsidising the SAPTCO and giving it a monopoly to run public buses in Saudi cities, to encourage the use of public transport, provide a reliable service for the public and organise the running of buses in Saudi cities. Despite strict regulations seeking to remove Coaster buses from

Saudi cities, in Riyadh, for example, 80% of bus users use Coaster buses while the SAPTCO's share is 20 % (Al-Qadi et al., 1993). This presents tough competition for the SAPTCO, although the Ministry of Transport and the Traffic Department tries to eliminate Coaster buses through very rigid conditions, such as their drivers must be Saudi, permission has to be given for vehicles which were in service before 1995 to operate, and vehicles must not be replaced with new ones. In Dammam, Coaster buses run on one route between Dammam and Khobar, so no Coaster buses run within the city.

The SAPTCO started its services in Dammam in 1979 with over 3.6 million passengers. Its services improved and the number of passengers rapidly grew to over 11 million within two years (see Table 4.15). However, the number of passengers dramatically declined in 1983 when ticket prices doubled and large numbers of foreign workers returned to their home countries, either because their employers had terminated their contracts or because of economic recession which led to their redundancy.

In 1987, the SAPTCO was running 15 routes, of which three served Dammam neighbourhoods. At present, only one of these three currently serves Dammam neighbourhoods. Other routes outside Dammam neighbourhoods may increase on Thursdays and Fridays to meet weekend travellers' needs (Table 4.16). Looking at SAPTCO routes in the Dammam area, it can be seen that the service was designed to link cities and villages near Dammam.

Table 4. 15 SAPTCO passengers in Dammam

Year	Passenger numbers	Percentage change (%)
1979	3605511	_
1980	8449101	134
1981	11227104	33
1982	11083198	-1
1983	7363161	-34
1984	6296757	-14
1985	5225126	-17
1986	5479587	5
1987	5172591	-6
1988	4555625	-12
1989	4468553	-2
1990	1375629	-69
1991	2403987	75
1992	2684046	12
1993	3605512	34
1994	3483269	-3
1995	3112529	-11
1996	3019528	-3
1997	3088025	2
1998	2490995	-19
1999	1855470	-26
2000	1223037	-34

Source: Compiled by the author based on primary data from SPTCO office in Dammam, Nov. 2002.

Table 4. 16 SAPTCO bus routes in the Dammam area

Route No.	Area Served	Route function	Existing Situation
1	Dammam – Khobar	Inter-city	Running
3	Dammam - Khobar via Dhahran airport	Inter-city	Cancelled
4	Qataif-Rahima via Safwa	Inter-city	Cancelled
5	Dammam-Khobar via the Coast Road	Inter-city	Cancelled
6	Dammam-Khobar via 1st street	Inter-city	Runs on Fridays
8	Khobar- Dhahran	Intra-city	Cancelled
9	Dammam- Qatif via Garudiyah	Inter-city	Cancelled
10A	Dammam – Um Alsahik	Inter-city	Running
10B	Dammam- Qatif via Anak	Inter-city	Cancelled
10C	Dammam- Seihat (Fridays only)	Inter-city	Cancelled
11	Dammam- Darin via Qatif	Inter-city	Running
21	Dammam bus station- 37 District	Intra-City	Cancelled
22	Dammam bus station- Jalawiyah District	Intra-City	Cancelled
27	Dammam port- 75 District	Intra-city	Runs on Fridays
28	Dammam - Industrial city	Intra-city	Runs on Thursdays and Fridays only
29	Dammam	Intra-city	Runs on Fridays
41	Khobar- King Fahad University Hospital	Intra-city	Cancelled

Source: Compiled by the author based on primary data from SPTCO office in Dammam, Nov. 2002.

Moreover, existing SAPTCO services are unreliable for workers and students. During weekdays, Saturdays to Wednesdays, the bus timetable runs between 2pm-11pm, so there are no scheduled morning trips. Table 4.17 clearly shows that SAPTCO services are primarily for travellers who travel outside working hours (evenings and weekends)

Table 4. 17 Number of Scheduled routes by time of operation

Day	Morning routes	Evening routes
Saturday to Wednesday	0	3
Thursday	3	4
Friday	7	7

Source: Compiled by the author based in primary data from SPTCO office in Dammam, Nov. 2002.

It can be concluded from looking at SAPTCO's existing services that Dammam is not served by convenient and reliable public buses. The existing service has no role to play in trips to school or work.

4.10.2 Taxi/limousine

In Dammam there are two types of taxi. The first one is owned by a company or by an establishment and is driven by a chauffeur. This type is called a limousine. The second is run by the car owner, who must be a Saudi. This type is called a taxi. Due to lack of public transport modes and school bus, many families depend on taxi and limousine to escort children to/from school. Female employees also depend on taxi and limousine to commute to/from workplace. The taxi/limousine market needs to be better organised. At present, the driver keeps moving on the road looking for customers. The Ministry of the Interior, perhaps for security reasons, forbids the use of wireless communication. This technology would reduce the distance travelled by taxi drivers and relieve congestion on the roads. Alghamdi (1999) reported average working hours for limousine drivers as 14.7 hours per day, over the limit of 9 hours prescribed by Saudi law. Alghamdi also noted that for 72% of the distance travelled, drivers were driving without a passenger. He also suggested that the poor safety record of limousine drivers was mainly due to the very long hours they worked and tiredness.

4.10.3 School Bus services in Dammam

As explained earlier, schools are segregated on a gender basis. Boys' schools are not served by official school bus services. On the other hand, some girls' schools are served by free and official services run by the educational authority. As can be seen from Table 4.18, the girls' schools authority limits school buses to intermediate and secondary schools only. Also, the service offered does not cover all students. The average coverage of schools served by school buses was 17.6 % in 2002, thus, there is a high demand for school buses which is not met.

4.10.4 Private mini-bus for school transport

Because of the high demand for school buses and the lack of services provided by the government, many individuals invest in school transport. Table 4.19 shows the number of vehicles for each licensed establishment. Noticeably, the number of buses owned by each establishment is quite small on average, per establishment. Mini-buses escort children to/from schools and colleges and serve female employees in their commute trip. The agreement with users, normally based on monthly payment, depends on the distance between users' homes and their destination.

Table 4. 18 Schools served by government provided school buses

School name	Student number	Number of buses	Bus capacity	% of students covered by bus
1st Tahfez Secondary	204	1	45	22
2nd Tahfez Secondary	353	1	55	16
1st Secondary	815	3	135	17
2nd Secondary	627	3	145	23
3rd Secondary	714	2	90	13
4th Secondary	770	3	115	15
5th Secondary	688	4	200	29
6th Secondary	570	2	100	18
7th Secondary	673	1	45	7
8th Secondary	947	4	170	18
9th Secondary	242	2	100	41
11th Secondary	1050	4	190	18
14th Secondary	367	1	45	12
16th Secondary	313	1	45	14
17th Secondary	490	1	45	9
19th Secondary	656	1	45	7
2nd Intermediate	554	3	155	28
4th Intermediate	981	4	145	15
5th Intermediate	727	4	180	25
6th Intermediate	477	3	135	28
7th Intermediate	450	1	45	10
8th Intermediate	420	1	45	11
9th Intermediate	788	3	145	18
10th Intermediate	565	2	90	16
11th Intermediate	653	2	100	15
13th Intermediate	860	3	135	16
14th Intermediate	550	2	70	13
16th Intermediate	624	3	135	22
17th Intermediate	252	1	55	22
18th Intermediate	580	1	55	9
19th Intermediate	214	1	55	26
27th Intermediate	365	1	45	12

Source: Compiled by the author based on primary data from the General Directorate for Girls' Education, Nov. 2002.

Table 4. 19 The number of buses registered per establishment

Establishment licence number	Number of buses
22	4
62	3
68	7
91	1
97	5
105	2
108	2
109	4
113	2
115	7
126	2
127	1
144	2
166	2

Source: Compiled by the author based on primary data from the General Directorate of Transport and Roads in Eastern Province, Nov. 2002.

4.11 Summary

This chapter has provided general background details on the city of Dammam, including its location, function, natural environment, population, and urban development. The chapter has also discussed the characteristics of Dammam's neighbourhoods.

Additionally, the chapter has provided a comprehensive overview of neighbourhoods selected by the researcher as samples of Dammam's neighbourhoods. Neighbourhoods' physical attributes have been reviewed: population, density, land uses, urban design, and spatial distribution of social services. Also, the chapter has detailed neighbourhoods' socio-economic characteristics: education level, occupation, income, household size, car ownership, and housing tenure.

The chapter has discussed the role of main players in transportation administration. Moreover, it has surveyed the constraints and opportunities relating to urban transportation, and introduced the supply side of transportation systems in Dammam. Further, it has described the existing condition of travel mode alternatives.

The following chapter will discuss the travel behaviour of Saudi households. The chapter will present the primary results of travel behaviour in Dammam city.

CHAPTER FIVE

Household Travel Behaviour

5.1 Introduction

The aim of this chapter is to accomplish the first research objective, namely, to identify the travel behaviour characteristics of Saudi households. The type of analysis employed in this chapter is statistical descriptive analysis of primary data collected through interviewing a sample of 380 households in Dammam who detailed their travel activities in a travel diary over a 24 hour period. This chapter's methodology is based on the frequency of household observations, i.e. travel mode, travel purpose, and travel times, etc. The research strategy in sections 5.2, 5.3 and 5.4 is based on cross tabulation analysis applying a chi-square test of independence based on the assumption that there is no association between travel behaviour and selected households' characteristics and neighbourhood characteristics. Based on this assumption, the expected values on contingency tables are calculated. Chapters six and seven provide a complete analysis of the influence of all factors simultaneously on travel behaviour.

The life of Saudis is determined by religious and social values. In the Saudi community, women's privacy is extremely important. Female travel is complex because females are restricted for two reasons: firstly, Saudi regulations prohibit women from driving and, secondly, the existing public transport is inefficient and does not provide adequate privacy for women (Alfozan,1995, p.110).

Due to restrictions on female travel, female members of a household become largely dependent on adult males in the household for performing their travel activities, which necessitates a family car. Otherwise, they will be given a lift by a male driver hired as a full-time chauffeur. Table 5.1 shows the age-gender structure of the Saudi population. The table indicates that almost three-quarters of the population (i.e. females and children aged 0-17) are not permitted to drive a car. This means that the majority of the population depend on a quarter of the population who are male and qualified to drive cars.

Table 5. 1 Age-gender distribution of the Saudi population

Age	Male	%	Female	%
0 - 17	2,560,455	22.40	3,397,906	29.73
18+	2,774,394	24.27	2,696,354	23.59
Total	5,334,849	46.67	6,094,260	53.32

Source: Central Department of Statistics, 1993.

This situation of high dependency on adult males to perform travel activities has influenced the travel pattern in households, for instance, by forcing many families to recruit foreigners as male chauffeurs. Although the majority of households do not want strange men participating in their activities, especially women's activities, they have no other option. Moreover, the high dependency on adult males to perform travel activities puts pressure on male family members who are not qualified to drive. This may include forcing under-age male members to drive without driving licences, or older males who are not fit to drive to continue driving. Car driving by these two groups is illegal and is clearly not in the public interest due to the high risk of car accidents (Alfozan, 1995, p.112).

Section 5.2 presents the travel behaviour characteristics of households. These characteristics include: travel time, travel mode, travel purpose, number of tour legs, purpose of secondary stops, and tour types. Section 5.3 discusses the association between household characteristics and travel behaviour. Section 5.4 presents an

analysis of the association between neighbourhood characteristics and travel behaviour.

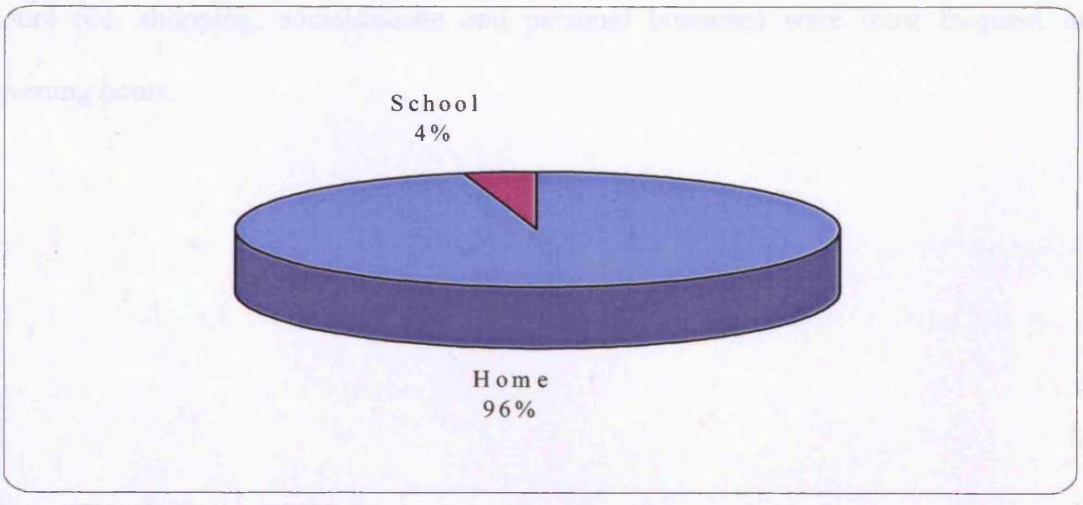
5.2 Household travel characteristics

This part aims to describe the pattern of household travel behaviour. In this research, household tour is the basic unit of measurement. A tour is defined as a sequence of trip segments that starts at home and ends at home. As explained in the research methodology (see chapter three, section 3.3.2), tour-based analysis has been chosen by the researcher instead of trip-based analysis because the study's aim is to investigate the complexity of household tours. Household travel behaviour is presented through describing tours undertaken by all household members for all purposes by all travel modes.

5.2.1 Travel start location

It is important to know from where the tour commences, and, as expected, Figure 5.1 shows that 96 per cent of tours started from home, whereas only four per cent started from school. Some children were given a lift to school from home in the morning and returned home by a different travel mode (i.e. by walking or by school bus), so the return journey is categorised as a separate "tour"

Figure 5. 1 Travel start location



Source: Household survey, 2003.

5.2.2 Travel time

Time of travel provides important data for understanding travel variation during the daytime in cities. Table 5.2 shows tours' start and end times. It can be seen that travel activities varied according to the time of day. The majority of tours started in morning peak times when work usually commences and schools open. Tours' end times also varied. Table 5.2 shows tours commonly ended at noon as this is the time when primary schools close and commercial shops close for the noon break. In the evening peak hours, most non-work tours ended.

Table 5. 2 Tours' start and end times

Time		Tours' start time (%)	Tours' end time (%)
2:00 - 6:29	Early off peak	8.2	5
6:30 - 8:00	AM peak	29.9	5.6
8:01- 10:59	AM off peak	2.3	1.9
11:00-12:30	Noon peak	8.8	17.4
12:31-13:59	Noon off peak	6.9	14.8
14:00 -15:00	Afternoon peak	0.9	7.3
15:01 -16:30	Afternoon off peak	10.4	9.2
16:31 -20:30	Evening peak	28.4	27.3
20:31 -1:59	Evening and early morning off peak	4.0	11.5

Source: Household survey, 2003.

Travel start and end times differed according to tour purpose. Table 5.3 shows tours' time versus tour purposes and indicates clear differences according to time of day. Work and school tours were generated in the morning peak whereas non-work tours (i.e. shopping, social/leisure and personal business) were most frequent in evening hours.

Table 5. 3 Tours' times

Time	Tour Purpose (%)											
	Work		Education		Spiritual		Shop		Social/ leisure		Personal business	
	St.	En	St.	En	St.	En	St.	En	St.	En	St.	En
Early off peak	12	0.6	6.5	0.6	19.1	19.4	0.7	0.7	0	0	0.8	0.8
AM peak	62	5.9	87.6	17.3	0	0	3.1	1.4	2.1	0.3	15	0.8
AM off peak	2.8	2.9	1.0	1.4	0	0	6.6	4.8	3.6	1.8	10	7.5
Noon peak	3.6	16.2	1.3	33.6	9.7	9.6	2.1	4.8	0.9	3.6	4.2	16.7
Noon off peak	6.2	11.2	0.8	37.7	0	0	1	1	0.6	0.6	1.7	3.3
Afternoon peak	2.4	28.7	0.2	5.9	0	0	0.3	0.3	0	0.6	3.3	3.3
Afternoon off peak	6.6	12.4	1.1	0.9	25.7	25.4	9.7	3.5	8.4	0.9	15	2.5
Evening peak	4.8	16.0	1.0	2.0	45.5	45.5	60.2	52.6	69.2	42.8	45.8	47.5
Evening and early morning off peak	0.6	6.3	0.6	0.8	0	0.2	16.3	30.8	15.3	49.8	4.2	17.5

Source: Household survey, 2003.

Tour type varied significantly over time. About half of complex tours (48.9%) started in the morning peak period and 20% occurred in the evening peak period. This finding suggests tours tended to be more complex if they started in peak hours than in off peaks periods (see Table 5.4).

In contrast, tour end periods were distributed more evenly over time. The most popular time for complex tours to end was the noon peak, when schools finish and people are involved in chauffeuring children from school to home and may stop at different schools. Also, it can be noted that more than 17% of education tours end in the morning peak, due to household heads or chauffeurs dropping children at school and then returning home. Table 5.5 shows there is an association between tour type and travel time (i.e. tours' start and end time).

Table 5. 4 Tour type by tour start time

Tour start time		Tour Type		Total
		Simple	Complex	
Early off peak	Count	194	30	224
	Expected	187	37	224
	%	8.5%	6.6%	8.2%
AM peak	Count	600	222	822
	Expected	608	135.9	822
	%	26.6%	48.9%	29.9%
AM off peak	Count	47	15	62
	Expected	51.7	10.3	62
	%	2.1%	3.3%	2.3%
Noon peak	Count	206	37	243
	Expected	202.8	40.2	243
	%	9.0%	8.1%	8.8%
Noon off peak	Count	164	25	189
	Expected	157.8	31.2	189
	%	7.2%	5.5%	6.9%
Afternoon peak	Count	24	2	26
	Expected	21.7	4.3	26
	%	1%	0.4%	0.9%
Afternoon off peak	Count	263	22	285
	Expected	237.9	47.1	285
	%	11.5%	4.8%	10.4%
Evening peak	Count	696	90	786
	Expected	656	130	786
	%	30.4%	19.8%	28.6%
Evening and early morning off peak	Count	98	11	109
	Expected	91	18	109
	%	4.3%	2.4%	4%
Total		2292	454	2746

Chi-square statistics= 106.89 (df=8), significant at p= 0.000.

Table 5. 5 Tour type by tour end time

Tour end time		Tour type		Total
		Simple	Complex	
Early off peak	Count	134	30	136
	Expected	113.5	37	136
	%	5.8%	0.4%	5.0%
AM peak	Count	76	78	154
	Expected	128.5	25.5	154
	%	3.3%	17.2%	5.6%
AM off peak	Count	38	15	53
	Expected	44.2	8.8	53
	%	1.7%	3.3%	1.9%
Noon peak	Count	386	91	477
	Expected	398.1	78.9	477
	%	16.8%	20%	17.4%
Noon off peak	Count	343	63	406
	Expected	338.9	67.1	406
	%	15%	13.9%	14.8%
Afternoon peak	Count	145	56	201
	Expected	167.8	33.2	201
	%	6.3%	12.3%	7.3%
Afternoon off peak	Count	233	20	253
	Expected	211.2	41.8	253
	%	10.2%	4.4%	9.2%
Evening peak	Count	672	77	749
	Expected	652.2	123.8	749
	%	29.3%	17%	27.3%
Evening and early morning off peak	Count	265	52	317
	Expected	264.6	52.4	317
	%	11.6%	11.5%	11.5%
Total		2292	454	2746

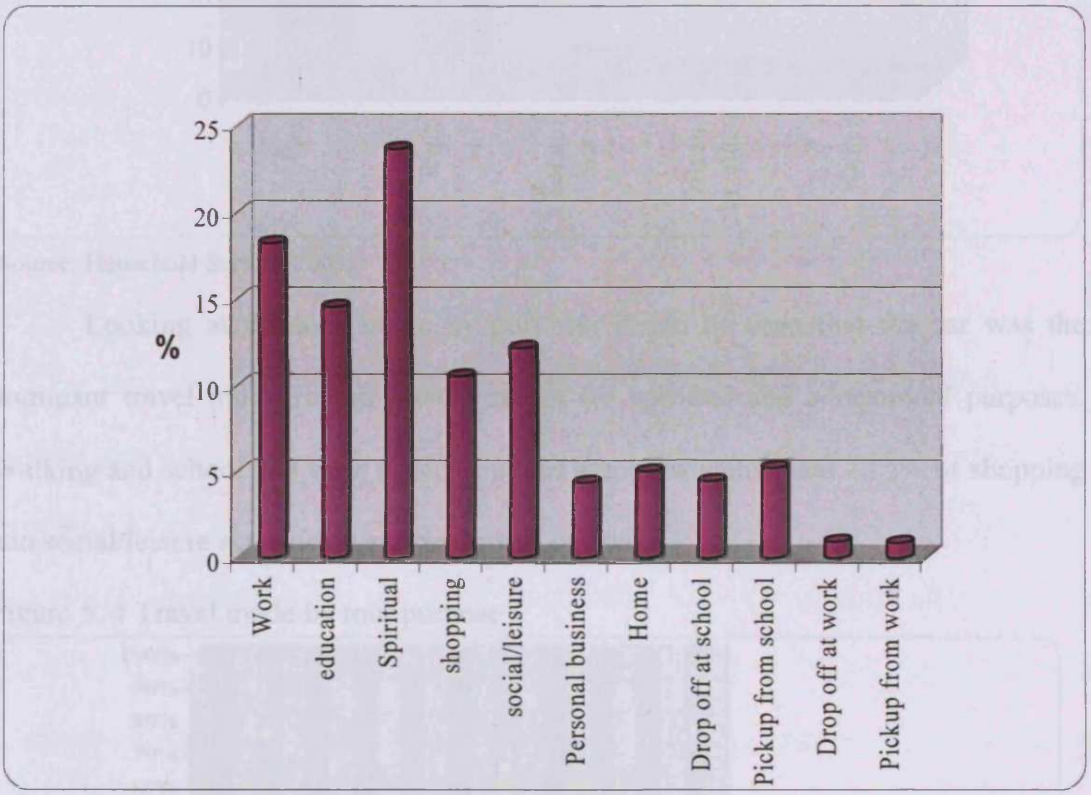
Chi-square statistics= 213.67 (df=8), significant at p= 0.000.

5.2.3 Tour's main purpose

A tour can be structured for more than one purpose, i.e. a multi-stop tour. In this case, the main purpose of the tour is decided by looking at activity duration so the tour purpose is identified as the activity which has the longest duration (refer to Chapter Three, section 3.3.2). From Figure 5.2, it can be seen that a tour's purpose can include: work, education, spiritual, shopping, social/leisure, and personal business. Figure 5.2 indicates that a spiritual purpose (tour to mosque) was the most frequent purpose. Almost a quarter (24%) of all household travel activities ended at

the mosque. This gives an indication of the importance of spiritual activities to Saudis. Tours to work were the most frequent travel purpose, forming 18% of all household travel activities. Educational tours made by students on their own made up 14.5%. Dropping children off at school and picking them up from school accounted for 4% and 5%, respectively. Social/leisure activities were high among travel activities recorded on weekdays (12%). This may be due to the fact that Saudis are sociable and maintain strong family links with relatives.

Figure 5. 2 Travel main purpose



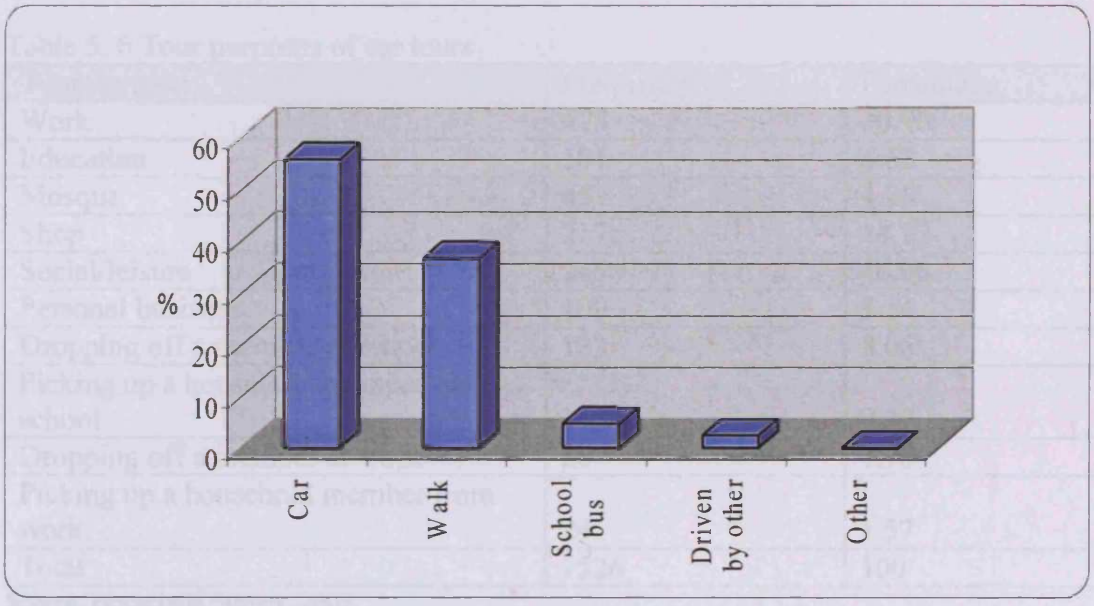
Source: Household Survey, 2003.

5.2.4 Travel mode

Tour mode data is used to identify the most popular travel mode among travellers. The study covered all travel activities performed outside the house regardless of distance or time. Figure 5.3 shows that the car, as expected, is the most dominant travel mode. Walking tours accounted for more than one-third of tours (37%), as a consequence of the need to fulfil spiritual requirements and the location of

mosques near homes. Finally, public buses were rarely used: only one person of the sampled households used public transport.

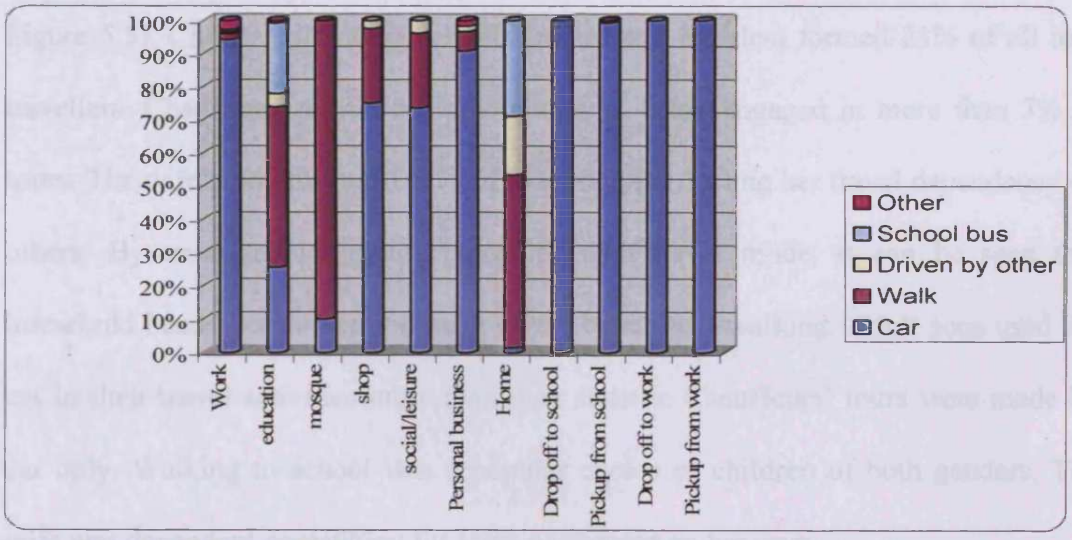
Figure 5. 3 Travel mode



Source: Household Survey, 2003.

Looking at the tour mode by purpose, it can be seen that the car was the dominant travel mode for all travel, except for spiritual and educational purposes. Walking and school bus were popular modes among students, and 22.5% of shopping and social/leisure activities were performed on foot.

Figure 5. 4 Travel mode by tour purpose



Source: Household Survey, 2003.

By looking at car tour purpose, it can be seen that work and school (educational tours and giving lifts to school) were the most frequent purposes for car tours, 30.9% and 24%, respectively, as shown in Table 5.6.

Table 5. 6 Tour purposes of car tours

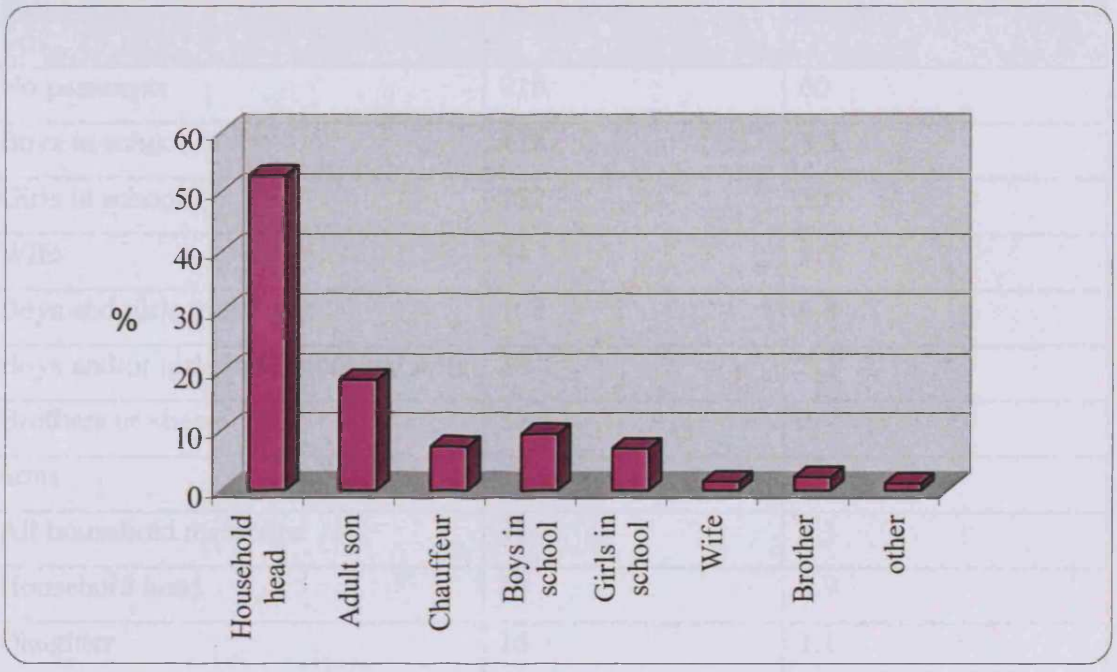
Tour purpose	Frequency	Percentage
Work	473	30.90
Education	101	6.62
Mosque	65	4.26
Shop	217	14.22
Social/leisure	245	16.06
Personal business	109	7.14
Dropping off a member at school	123	8.06
Picking up a household member from school	143	9.37
Dropping off a member at work	26	1.70
Picking up a household member from work	24	1.57
Total	1526	100

Source: Household Survey, 2003.

5.2.5 Tour traveller

Tour traveller refers to the traveller who performs the travel activities. As regards car tours, the traveller is the driver. Tour passengers' characteristics are presented in the following section. The household head was the busiest member of the household regarding travel activities, performing 53% of all such activities (see Figure 5.5). Children attending schools (males and females) formed 21% of all tour travellers. Chauffeurs played an important role, being engaged in more than 7% of tours. The wife alone formed 1.5 % of tours only, reflecting her travel dependency on others. By cross tabulating tour traveller with travel mode, it can be seen that household heads' tours were, in most cases, by car and walking. Adult sons used the car in their travel activities more than their fathers. Chauffeurs' tours were made by car only. Walking to school was a popular choice of children of both genders. The wife was dependent on walking for tours performed on her own.

Figure 5. 5 Tour travellers

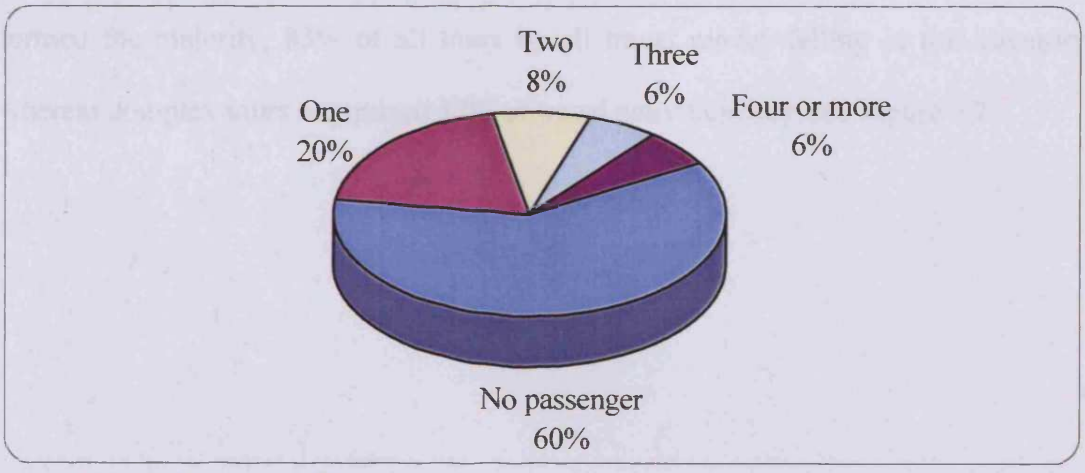


Source: Household Survey, 2003.

5.2.6 Tour passengers

The number of passengers can be considered an indication of the travel dependency within households. Figure 5.6 shows that the majority of car tours were performed with no passengers (60%), 20% were performed with one passenger, and 20% with two passengers or more. Car occupancy was 1.8 persons/car (mean). Table 5.7 shows that school-children constituted the majority of passengers. Almost 70% of tour passengers were students.

Figure 5. 6 Number of tour passenger



Source: Household Survey, 2003.

Table 5. 7 Tour Passenger types

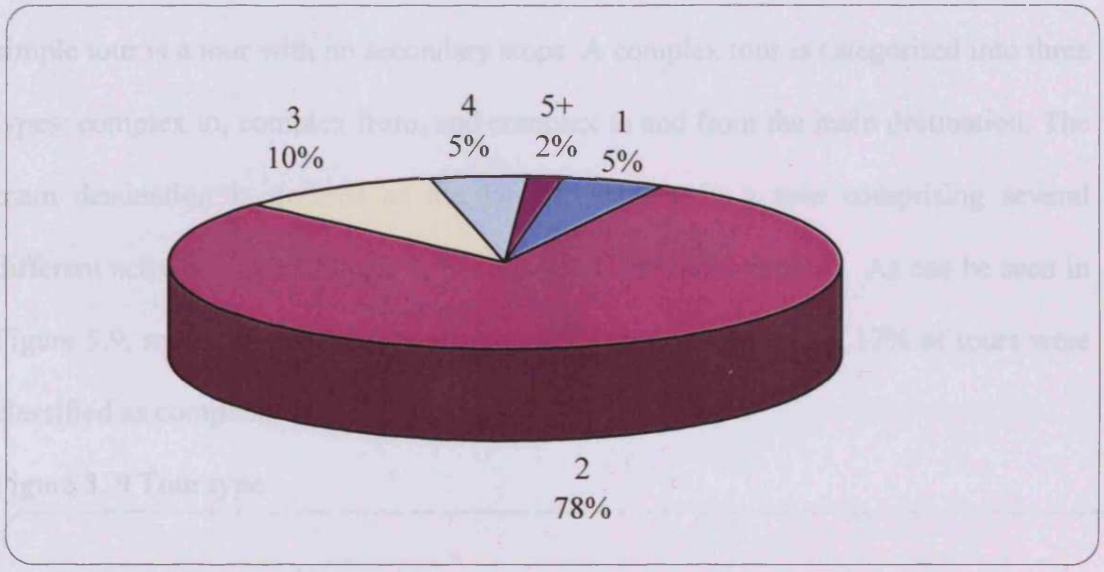
Passenger	Frequency	Per cent
No passenger	919	60
Boys in school	128	8.5
Girls in school	152	10
Wife	41	2.7
Boys and girls in schools	103	6.8
Boys and/or girls in schools and wife	38	2.5
Brothers or sisters	31	2
Sons	15	1
All household members	32	2.1
Household head	13	0.9
Daughter	16	1.1
Other	26	1.7

Source: Household Survey, 2003.

5.2.7 Tour type

The number of trip legs is an indicator of a car tour's complexity. A simple tour contains two stops (origin and destination) e.g. home-work-home. If there are more stops than this, the tour is considered complex (see chapter three, section 3.3.2, for more details). Tour complexity is an indicator of a traveller's engagement in activities either for himself or for other members in the household. Simple tours, tours with two legs (or one leg for students who return home on their own from school), formed the majority, 83% of all tours by all travel modes falling in this category, whereas complex tours comprised 17% of travel activities only, see Figure 5.7.

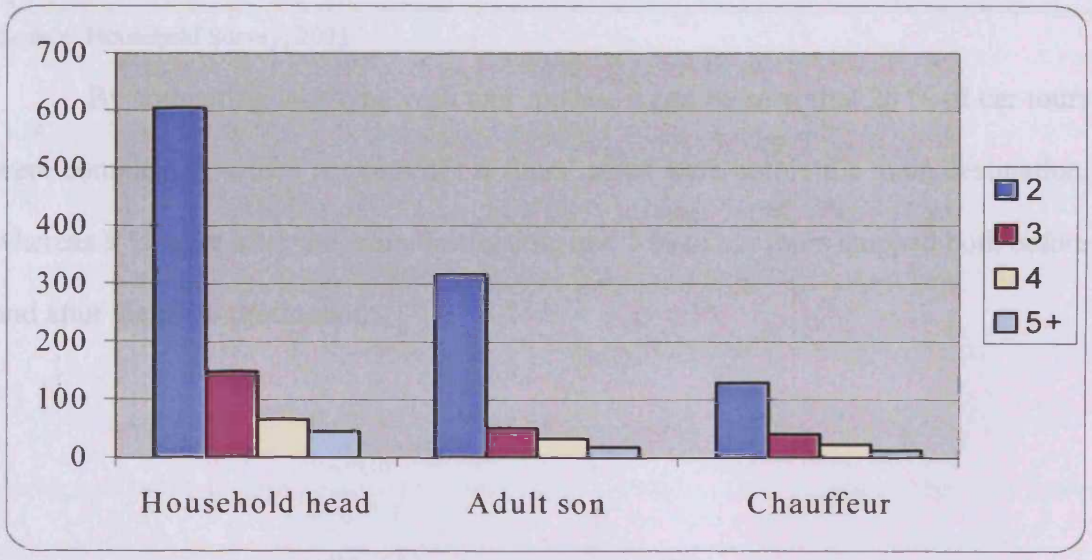
Figure 5. 7 Number of trip legs



Source: Household Survey, 2003.

Figure 5.8 shows the association between travel complexity and tour driver for car tours. It can be seen that 70% of household heads' car tours were simple and 30% were complex whereas only a quarter, of those made by adult sons' tours were complex. These findings reflect the household head's higher participation in household travel activities compared with other household members. Chauffeurs tended to perform the most complex tours, 37% of their tours being complex.

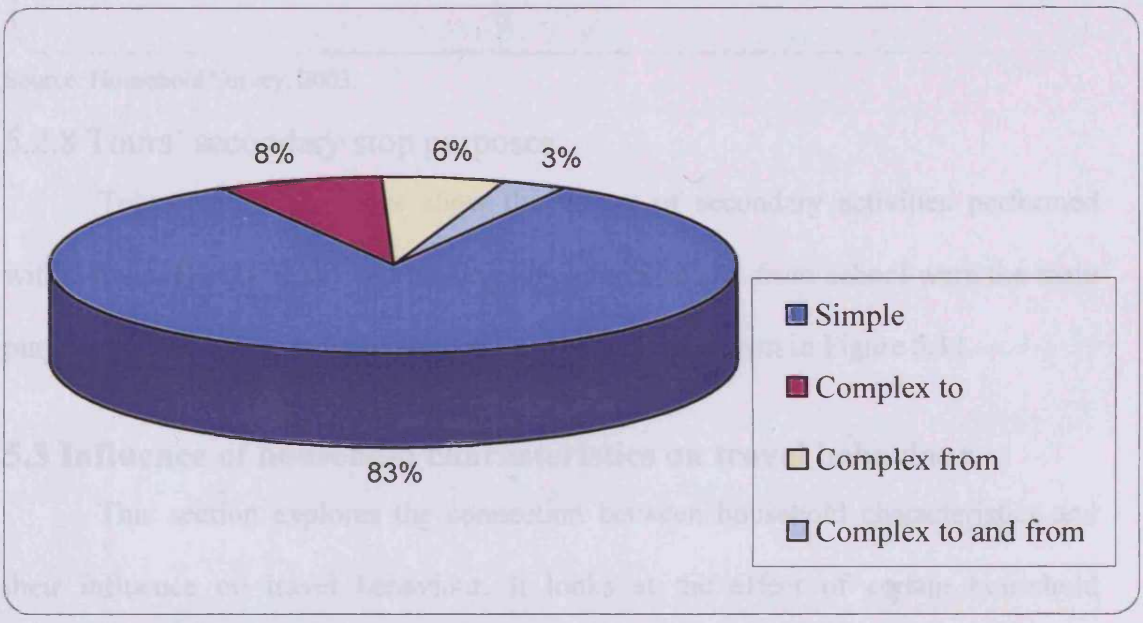
Figure 5. 8 Tour trip legs by traveller



Source: Household Survey, 2003.

Tour types were classified according to the number and location of stops. A simple tour is a tour with no secondary stops. A complex tour is categorised into three types: complex to, complex from, and complex to and from the main destination. The main destination is defined as the longest activity in a tour comprising several different activities (see Chapter 3, Section 3.3.2, for more details). As can be seen in Figure 5.9, more than two-thirds of tours (83%) were simple, and 17% of tours were classified as complex.

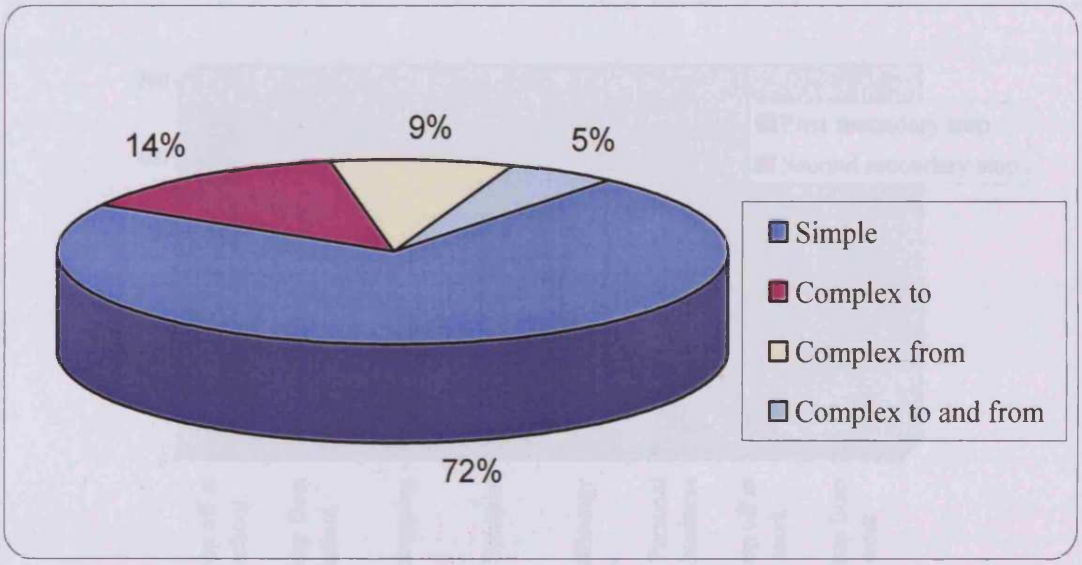
Figure 5. 9 Tour type



Source: Household Survey, 2003.

By comparing tour type with tour modes, it can be seen that 28 % of car tours were complex. Fourteen per cent of car tours' stops were before the main destination, whereas 9 % were after the main destination, and 5 % of car tours stopped both before and after the main destination.

Figure 5. 10 Car tour types



Source: Household Survey, 2003.

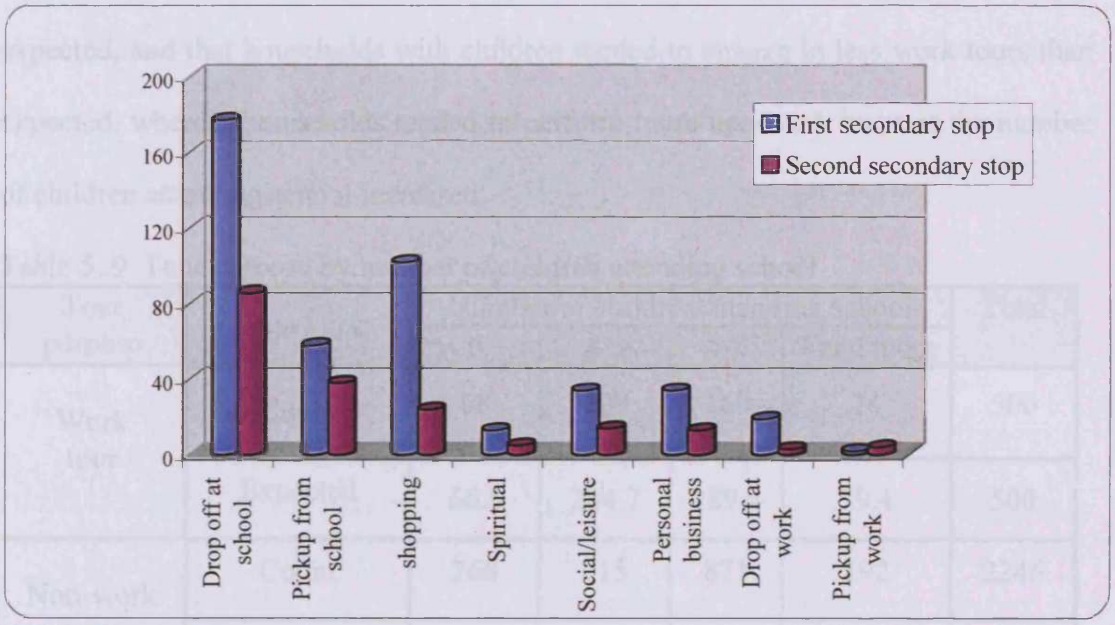
5.2.8 Tours' secondary stop purposes

Tours' secondary stops show the nature of secondary activities performed within tours. Dropping off and picking up children to and from school were the main purposes of secondary stops, followed by shopping, as shown in Figure 5.11.

5.3 Influence of household characteristics on travel behaviour

This section explores the connection between household characteristics and their influence on travel behaviour. It looks at the effect of certain household characteristics singly on travel behaviour, while chapters six and seven look at the simultaneous joint effect of all household and neighbourhood characteristics on travel behaviour. In this section, the study hypothesises that there is no association between the household's travel complexity and household characteristics (level of education, number of children at school, availability of chauffeur, number and gender of employees, and household income). Car ownership was found to have no significant influence on travel behaviour, possibly due to the high level of car ownership in Saudi households (58.5% of households had two cars or more).

Figure 5. 11 Secondary Stops' purposes



Source: Household Survey, 2003.

5.3.1 Household head's level of education

The household head's level of education was shown to have an influence on travel behaviour. Table 5.8 shows a significant association between the household head's level of education and tour complexity; as the household head's educational level increased, the household tended to perform more complex tours

Table 5. 8 Tour type by household head's educational level

Tour Type		Household's head educational level				Total
		Illiterate	Low education	Middle level of education	High level of education	
Simple	Count	159	1018	659	456	2292
	Expected	151.9	1004.1	660.2	475.8	2292
	%	87.4%	84.6%	83.3%	80%	83.59%
Complex	Count	23	185	132	114	454
	Expected	30.1	198.9	130.8	94.2	454
	%	12.6%	15.4 %	16.7%	20%	16.5%
Total		182	1203	791	570	2746

Chi-square statistics= 8.14 (df=3), significant at p= 0.043.

5.3.2 Number of children attending school

There was a significant association between the number of children attending school and household travel behaviour. Table 5.9 shows that households with no

children attending school tended to perform more work tours than statistically expected, and that households with children tended to engage in less work tours than expected, whereas households tended to perform more non-work tours as the number of children attending school increased.

Table 5. 9 Tour purpose by number of children attending school

Tour purpose	Tour Type	Number of children attending school				Total
		0	1-3	4-6	7 and more	
Work tour	Count	98	209	169	24	500
	Expected	66.6	204.7	189.4	39.4	500
Non-work tour	Count	268	915	871	192	2246
	Expected	299.4	919.3	850.6	176.7	2246

Chi-square statistics= 28.136 (df=3), significant at p= 0.000.

The results of chi-square in Table 5.10 show that there are more simple work tours than expected if 1 to 3 children attend school. Households with 4 to 6 children attend school are involved in more complex work tours than expected. This may be reflect the structure of the household. In households with 4 to 6 children the chance of having children attending different levels of school (e.g. primary, intermediate and high school) is greater than for households with 1 to 3 children. As children attend different schools, household engagement in complex tours increases.

Table 5. 10 Work tour type by number of children attending school

Tour type	Tour Type	Number of children attending school				Total
		0	1-3	4-6	7 and more	
Simple	Count	69	157	102	18	346
	Expected	67.8	144.6	116.9	16.6	346
Complex	Count	29	52	67	6	154
	Expected	30.2	64.4	52.1	7.4	154

Chi-square statistics= 10.085 (df=3), significant at p= 0.018.

As the number of children attending school increases, households tend to perform more complex non-work tours than expected (see Table 5.11). From Tables 5.10 and 5.11, the researcher found that there is an association between number of children attending school and tour complexity. Chi-square tests in both tables were significant and these imply that number of children does influence tour complexity for both work and non-work tours.

Table 5. 11 Non-work tour type by number of children attending school

Tour type	Tour Type	Number of children attending school				Total
		0	1-3	4-6	7 and more	
Simple	Count	239	808	740	159	1946
	Expected	232.2	792.8	754.7	166.4	1946
Complex	Count	29	107	131	33	300
	Expected	35.8	122.2	116.3	25.6	300

Chi-square statistics= 8.243 (df=3), significant at p= 0.041.

5.3.3 Availability of chauffeur

Households tended to perform more complex tours if they had a chauffeur. A significant association between tour complexity and availability of chauffeur was found as shown in Table 5.12.

Table 5. 12 Tour type by availability of chauffeur

Tour Type		Availability of chauffeur		Total
		No	Yes	
Simple	Count	1828	464	2292
	Expected	1805	486.6	2292
	%	84.5%	79.6%	83.59%
Complex	Count	23	119	454
	Expected	30.1	96.4	454
	%	12.6%	20.4 %	16.5%
Total		2163	583	2746

Chi-square statistics= 8.06 (df=1), significant at p= 0.003.

5.3.4 Number of employees

The number of employees in the household was shown to have a significant influence on the type of work tours. In the present study, as the number of male employees increased, work tours tended to have a simpler structure (see Table 5.13). This finding supports that of Krizek (2003b) who found that the larger the number of employees in households, the less likely households linked trips.

Table 5. 13 Work tour type by number of male employees

Work Tour Type		Number of male employees			Total
		1	2	3 and more	
Simple	Count	187	76	76	339
	Expected	200.7	71.3	67.1	339
Complex	Count	103	27	21	151
	Expected	89.3	31.7	29.9	151
Total		290	103	97	490

Chi-square statistics= 7.85 (df=2), significant at p= 0.049.

The reverse occurs with the number of females in employment. Table 5.14 shows that as the number of females in employment increases, tour complexity also increases. This is because a female employee largely depends on an adult male member to travel to and from work.

Table 5. 14 Work tour type by number of female employees

Tour Type		Number of female employees		2292
		0	1 and more	Total
Simple	Count	281	65	346
	Expected	272.6	73.4	346
	%	71%	61.3%	69.2%
Complex	Count	113	41	154
	Expected	121.4	32.6	154
	%	28.7%	38.7 %	30.8%
Total		394	106	500

Chi-square statistics= 3.91 (df=1), significant at p= 0.048.

5.3.5 Household head's income

Table 5.15 shows an association between work tour complexity and household income. Low income households tended to perform simpler work-tours, whereas higher income groups tended to perform more complex work-tours than expected.

Strathmen and Ducker (1995) reported that higher income groups exhibited a greater tendency to combine work and non-work trips.

Table 5. 15 Work tour type by household head's income

Work Tour Type		Household head's income				Total
		Less than 3000 SR	3001-7000SR	7001-8999 SR	9000 SR and more	
Simple	Count	46	133	53	106	338
	Expected	36	137.7	55.4	110.7	338
Complex	Count	6	66	27	54	153
	Expected	16	61.3	24.6	49.3	153
Total		52	199	80	160	491

Chi-square statistics= 12.19 (df=3), significant at p= 0.016.

5.4 Variation in travel behaviour over neighbourhoods

In Chapter Four, Section 9, the physical characteristics of neighbourhoods were discussed. This section examines the association between travel behaviour and neighbourhood characteristics.

5.4.1 Tour purpose by neighbourhoods

Table 5.16, shows that neighbourhoods were significantly associated with tour purpose. In Alkhaleej and Alaziziah, where household size was larger and the number of employees in households was higher than in other neighbourhoods, work tours were far more than statistically expected. In Jamayen, which had the highest number of retired household heads, work tours were fewer than statistically expected. Residents of Alkhaleej and Alaziziah performed less mosque tours than expected. The number of children returning home on their own from school in Alaziziah was double that expected probably due to the denser network distribution of schools in the neighbourhood, which makes it easy for children to walk home from school (37 tours were made from school to home). Jamayen's households performed more tours to take children to and from school (40 tours to drop children at school and 52 tours to pick them up from school) and to take employees to and from work than expected,

probably due to the greater availability in this neighbourhood of chauffeurs recruited to serve household members' needs.

Table 5. 16 Tour purpose by neighbourhood.

Tour purpose		Neighbourhoods							Total
		Khaleej	AlJam-ayyn	Iscan	Ghar-natah	Roabi	Aziziah	Petromin	
Work	Count	86	83	68	76	81	74	32	500
	Expected	60.8	113.3	75.2	76.5	84.7	54.8	34.8	500
Education	Count	89	67	76	28	61	50	28	399
	Expected	48.5	90.4	60	61	67.6	43.7	27.8	399
Mosque	Count	36	185	107	144	106	20	51	649
	Expected	78.9	147	97.6	99.3	109.9	71.1	45.1	649
Shop	Count	29	57	45	44	53	44	17	289
	Expected	35.2	65.5	43.5	44.2	48.9	31.7	20.1	289
Social/ leisure	Count	42	67	55	51	51	42	26	334
	Expected	40.6	75.7	50.2	51.1	56.6	36.6	23.2	334
Personal business	Count	8	24	20	20	28	13	7	120
	Expected	14.6	27.2	18	18.4	20.3	13.2	8.3	120
home	Count	18	19	17	13	21	37	13	138
	Expected	16.8	31.3	20.8	21.1	23.4	15.1	9.6	138
Drop off at school	Count	11	40	13	15	28	10	6	123
	Expected	15	27.9	18.5	18.8	20.8	13.5	8.6	123
Pick up from sch.	Count	11	52	12	24	30	8	7	144
	Expected	17.5	32.6	21.7	22	24.4	15.8	10	144
Drop off at work	Count	2	13	0	3	3	2	3	26
	Expected	3.2	5.9	3.9	4	4.4	2.8	1.8	26
Pick up from work	Count	2	15	0	2	3	1	1	24
	Expected	2.9	5.4	3.6	3.7	4.1	2.6	1.7	24
Total		334	622	413	420	465	301	191	2746

Chi-square statistics= 316.29 (df=60), significant at p= 0.000.

5.4.2 Travel modes by neighbourhood

Travel mode was found to be significantly associated with neighbourhood. In Alkhaleej, a poor area, residents participated in car tours less than statistically expected; on the other hand, they were involved in more walk tours than statistically expected (see Table 5.17). In contrast, in Al-Jamayyen, a high income area, residents performed more car tours and fewer walking tours than expected. Households in

Iscan, a high density area with pedestrian-oriented development, walked more than expected.

Table 5. 17 Travel mode over neighbourhoods

Travel mode		Neighbourhoods							Total
		Khaleej	AlJam-ayyn	Iscan	Ghar-natah	Roabi	Aziziah	Petromin	
Car	Count	151	385	204	231	272	182	101	1526
	Expected	185.6	345	229.5	233.4	258.4	167.3	106.1	1526
Walk	Count	154	193	184	161	151	96	66	1005
	Expected	122.2	227.6	151.2	153.7	170.2	110.2	69.9	1005
Driven by another	Count	5	15	4	14	14	7	6	65
	Expected	7.9	14.7	9.8	9.9	11	7.1	4.5	65
Other	Count	24	29	21	14	28	16	18	150
	Expected	18.2	34	22.6	22.9	25.4	16.4	10.4	150
Total		334	622	413	420	465	301	191	2746

Chi-square statistics= 60.60 (df=18), significant at p= 0.000.

Additionally, travel mode was found to be significantly associated with tour purpose in neighbourhoods. Table 5.18 indicates that in all neighbourhoods, households performed more work tours by car than statistically expected; in most cases, twice the expected number. By contrast, the number of non-work tours by car was lower than expected. Non-work tours were mostly performed on foot, mainly tours to mosques, shops, and to visit a friend/relative.

5.4.3 Tour traveller by neighbourhood

Tour travellers varied over neighbourhoods. In Iscan and Gharnatah, household heads performed more tours than statistically expected, thus households depended highly on household heads (see Table 5.19). In Aljamayen, household heads performed fewer tours than statistically expected, presumably due to the availability of chauffeurs who performed three times as many as expected. In Alaziziah, household heads performed fewer tours than expected, probably because children of both genders attending school were more likely to be able to travel on their own to

school than in other neighbourhoods. Children of both genders travelled on their own twice as much as expected.

Table 5. 18 Tour type by tour mode over neighbourhoods

Neighbourhood	Tour Type		Tour mode			Total
			Car	Walk	Other	
Alkhalej[1]	Work	Count	73	6	7	86
		Expected	38.9	39.7	7.5	86
	Non-work	Count	78	148	22	248
		Expected	112.1	114.3	21.5	248
Jamayen[2]	Work	Count	82	0	1	83
		Expected	51.4	25.8	5.9	83
	Non-work	Count	303	193	43	539
		Expected	333.6	167.2	38.1	539
Iscan[3]	Work	Count	64	1	3	68
		Expected	33.6	30.3	4.1	68
	Non-work	Count	140	183	22	345
		Expected	170.4	153.7	20.9	345
Gharnatah[4]	Work	Count	73	0	3	76
		Expected	41.8	29.1	5.1	76
	Non-work	Count	158	161	25	344
		Expected	189.2	131.9	22.9	344
Alroabi[5]	Work	Count	79	1	1	81
		Expected	47.4	26.3	7.3	81
	Non-work	Count	193	150	41	384
		Expected	224.6	124.7	34.7	384
Alaziziah[6]	Work	Count	69	1	4	74
		Expected	44.7	23.6	5.7	74
	Non-work	Count	113	95	19	227
		Expected	137.3	72.4	17.3	227
Petromin[7]	Work	Count	31	0	1	32
		Expected	16.9	11.1	4	32
	Non-work	Count	70	66	23	159
		Expected	84.1	54.9	20	159

Chi-square statistics for 1= 78.82, 2=55.45, 3= 67.23, 4= 65.03, 5= 61.63, 6= 46.77, 7= 30.08, (df=2), all significant at p= 0.000.

Table 5. 19 Tour travellers over neighbourhoods

Tour travellers		Neighbourhoods							Total
		Khaleej	AlJam-ayyn	Iscan	Ghar-natah	Roabi	Aziziah	Petromin	
Household head	Count	162	285	256	274	237	126	108	1448
	Expected	176.1	328	217	221.5	245.2	158.7	100.7	1448
Adult son	Count	45	99	70	93	99	69	36	511
	Expected	62.2	115.7	76.9	78.2	86.5	56	35.5	511
Chauffeur	Count	5	130	0	23	27	9	8	202
	Expected	24.6	45.8	30.4	30.9	34.2	22.1	14.1	202
Boys in school	Count	55	48	29	9	56	44	19	260
	Expected	31.6	58.9	39.1	39.8	44	28.5	18.1	260
Girls in school	Count	46	22	33	12	28	38	13	192
	Expected	23.4	43.5	28.9	29.4	32.5	21.0	13.4	192
Wife	Count	2	6	9	4	6	9	4	40
	Expected	4.9	9.1	6	6.1	6.8	4.4	2.8	40
Brother	Count	8	23	15	1	11	3	0	61
	Expected	7.4	13.8	9.2	9.3	10.3	6.7	4.2	61
Other	Count	11	9	1	4	1	3	3	32
	Expected	3.9	7.2	4.8	4.9	5.4	3.5	2.2	32
		344	622	413	420	465	301	191	2746

Chi-square statistics= 433.62 (df=42), significant at p= 0.000.

5.5 Summary

This chapter has provided a brief general picture of household travel behaviour, presenting in detail travel purpose, travel time, travel mode, and trip structures. The chapter has also discussed how the Saudi cultural and social environment influence household travel behaviour. Two factors make Saudi household travel behaviour unique. Firstly, women are not allowed to drive a car. Secondly, there are many tours to spiritual activities, i.e. tours to the mosque. Travel dependency on the household head is therefore high in the Saudi household.

As expected, the car was revealed to be the dominant travel mode, except for tours to mosques, to which travellers usually walked. The majority of car tours were simple tours. Complex work tours were associated with giving children lifts to and from school.

Household characteristics, such as level of education, number of employees, number of children attending school, availability of a chauffeur, and household head's income were found to significantly influence household travel behaviour, thus rejecting the null hypothesis which assumes there is no association between travel behaviour and household characteristics. In contrast, the null hypothesis is accepted in relation to household car ownership, which was found to have no significant influence on household travel behaviour, probably due to the high rate of car ownership among surveyed households (58.5% of households had two or more cars).

Study findings also rejected the null hypothesis assuming no association between neighbourhoods and travel behaviour. Neighbourhood characteristics, such as density and social services distribution, appeared to influence travel behaviour (travel mode, travel time, and tour traveller).

The following chapter will discuss the trip generation model in Dammam. It will look at the structure of trip generation models and the factors that affect trip generation in the Saudi community. The chapter will extend the data analysis by applying simultaneous joint factor effects analysis.

CHAPTER SIX

A Trip Generation Model for Saudi Households

6.1 Introduction

Trip generation is the first stage in classical four stage travel modelling, predicting the total number of trips that will be generated from each zone of a study area in a given time period. This chapter aims to explore the factors influencing the trip generation rate in a Saudi context. Here the rate is defined as the number of car trips generated by all household members in a twenty-four hour period. The analysis method applied in the current study is the Poisson Regression (PR) model (for a detailed explanation of this technique, see Chapter Three, Section 3.3.1).

The study aims to identify factors affecting trip generation rate in Saudi households. Section 6.2 discusses the factors influencing the trip generation rate and makes a comparison between factors which have been applied in a Western context and those expected to be influential in Saudi Arabia. Section 6.3 presents detailed results of the Saudi model, using all variables available.

6.2 Factors influencing trip generation

The trip generation rate is affected by many factors: socio-economic, cultural, demographic, and accessibility/density. This section will investigate which factors have been shown to have an influence on the trip generation rate, and which of them are applicable in the Saudi context.

6.2.1 Factors influencing trip generation model in Western cities

The literature review of trip generation models, Chapter Two, section 2.3.2, has reviewed many factors proved to influence the trip generation rate. these include the following:

a) **Household characteristics**: household attributes are a main determinant of trips generated by a household. Factors such as family size, family income, car ownership, household lifecycle, and employment status all have an effect on the trip generation rate.

b) **Residential area characteristics**: Residential density is considered important in the Western context, but is rarely used in models in the literature. The literature provides considerable evidence that higher density areas are associated with reduction in car travel (Ewing et al., 1994; Newman and Keworthy, 1998; Kitamura et al., 1997). Accessibility is another important factor which influences trip generation rate (Daly, 1997; Ortuzar and willumsen, 2001). Accessibility to public transport and services has been found to be significantly associated with modal split; for example, increase in distance to a bus stop will increase the number of car trips (Kitamura et al., 1997).

6.2.2 Factors expected to influence a Saudi household's trip generation rate

This section aims to introduce factors that are assumed to have an influence on a Saudi household's trip generation. A Saudi household trip generation model is expected to differ from a Western model for several reasons:

I. Difference in travel needs: in a Saudi context we find frequent travel to mosques to satisfy spiritual needs and more trips to schools because of segregated educational facilities.

II. Role of women: for cultural reasons, women in a Saudi context are largely dependent on males for performing their travel needs, whereas in the Western environment we find mothers make up 84% of drivers who drive their children to school (Morris et al., 2001)

III. Climate: is an importance factor influencing travel pattern. In high temperature and humid areas, people tend to ignore walking choice due to discomfort. Hence there is a large percentage of vehicular trips.

IV. Large family structure: the Saudi household is large in size with an average of 7.5 persons/household. This factor may influence the demand for travel within a household.

V. Availability of a chauffeur: one way of responding to travel demand within a household is to recruit a full time chauffeur. Availability of a chauffeur may influence travel behaviour.

VI. Transportation Supply side: lack of public transport, such as public buses and school transport, has led to high dependency on the car. This means household members' greater dependency on adult males who are able to drive to serve their travel needs.

This research therefore hypothesises that the following factors influence the Saudi household's trip generation rate:

a) **Characteristics of the head of the household:** as has been found from cross-tabulation analysis in chapter 5, section 5.2.5, the head of the household is the household member most likely to be involved in travel activities, mainly car trips. Educational level of the household head is a factor expected to influence trip generation, since the preliminary analysis in chapter 5 shows that a household's travel behaviour varies according to education level. Occupation is also expected to

influence trip generation rate, as a household with a head in a lower level of occupation (e.g. workman) is expected to produce less trips than a household with a head in a highly-skilled occupation (e.g. professional and administrative), due to social prestige and style of living. Households with heads in highly-skilled occupations will have more leisure and shopping activities. Also this group can meet the expense of hiring a chauffeur which leads to increases in the number of car trips. The employment sector is expected to have an influence on employees' travel behaviour due to difference in flexibility of employment factors, some employers allow employees to perform travel activities in working hours, while others do not. For example, employees in the civil service have more freedom to perform more trips in working hours, especially to escort children to and from school, than those in the military or private sectors, which have very strict rules which restrict employees from leaving the workplace in working hours. Working hours is another factor which might influence the number of trips generated by a household. A household where members work from 7:30 am to 2:30 pm will have the opportunity to participate in trips serving other household members' needs (e.g. escorting children on their way to work, performing trips in evening hours). In contrast, employees working morning and evening shifts are expected to produce more work related trips and perform fewer non-work trips, especially in the evenings. A household head who works a changeable shift is assumed to be less engaged in serving the travel needs for other household members because of change in his work times. Income is also a common variable used in the trip generation model.

b) **Household Structure:** a household is the unit for which the trip rate is estimated, so a household's attributes are essential parts of a trip generation model. Family size, number of children attending school and number of employees are expected to have

some influence on trip generation. Further, due to the Saudi socio-cultural environment, the research hypothesis is that a traveller's gender will be a factor influencing trip generation rate because of a female's travel dependency on adult male members. Therefore, the existence of female workers or female students in a household is expected to increase the number of car trips.

c) **Access to car:** access to a car in a Saudi household can be evaluated in two ways. First, car ownership; the Saudi household has one of the world's highest car ownership rates. This is due to the majority of households' ability to afford to buy a car, lack of public transport facilities, and the absence of car use restriction measures (i.e. road tax, fuel tax, road tolling, and parking charges). As the number of cars increases in a household this leads to more opportunities to perform car trips. Second, as the number of household members who are able to drive increases within the household, the number of car trips is expected to rise. As has been discussed in chapter 5 section 5.3.2, many Saudi households tend to recruit a full time chauffeur. A family with a chauffeur has more opportunities to undertake car trips.

d) **Neighbourhood and accessibility characteristics**: Neighbourhood attributes, such as density and spatial distribution of public services, are expected to influence the trip generation rate. Density in this study is a proxy for population concentration in neighbourhoods (i.e. number of residents per hectare). A high density area is expected to be better served by public services (e.g. mosques, schools and shops). Accessibility to public services is measured by the actual distance between home and the nearest public services' facilities (boys' primary school, girls' primary school, mosques and health centre). Accessibility is also measured by actual distance between home and the Central Business District (CBD) where governmental services and commercial enterprises are located. Finally, distance to work is measured by the actual distance

between the home and workplace of the household head. Distance to work is included in the trip generation model to answer the question: "Does the distance travelled by the household head to his workplace influence the number of car trips generated by household members?" Some might argue that, as distance to work increases, this will restrict the household head's ability to serve the travel needs of other household members, resulting in fewer car trips. Distance to work, the CBD, and public service facilities (i.e. schools, mosque) is measured in ArcView, using the "best route" tool.

6.3 Developing a trip generation model for a Saudi household

This section provides an explanation of methods used to develop a model which can be used to estimate car trip generation. Poisson Regression (PR) analysis was selected for use in this research. The PR model is an appropriate statistical technique to apply when the dependent variable is a count, such as the number of household car trips in a day. The PR model is particularly appropriate when the number of car trips has low values, which is typically the case (Lovett and Flowerdew, 1989).

As noted, the response variable of the model consists of the number of car trips performed by a household within 24 hours. The explanatory variables consist of the household head's attributes, household socio-economic characteristics, household structure, and neighbourhood characteristics. Table 6.1 details the different categories assigned to each variable used in the Poisson Regression model. Some of the variables are used in the model as dummy variables. The underlined categories are used as reference categories. Table 6.2 shows summary statistics of some variables used in the model. The analysis is undertaken using the LIMDEP 7 for Windows software package, which has the ability to run a Poisson Regression model directly. The results of the model (P value) will be tested at the 5% significance level (0.05).

Table 6. 1 Variables used in the trip generation model

Dependent Variable	Variable name	Categories
Number of car trips	CARTRIP	Real Number
Explanatory Variables	Variable name	Categories
Neighbourhood	NID	1= Al-Khaleej, 2= Jamayyen, 3= Iscan 4= Gharnata, 5= Al-Roabi, 6= Al-Aziziah, 7= Petrumin
Household head's level of education	HEDUC	1- Illiterate 2- Can read and write 3- Primary school 4- Intermediate school 5- Secondary school 6- Technical institute 7- University graduate 8- Postgraduate
Household head's Occupation	OCCUP	1- Professional 2- Administrative 3- Businessman 4-Workman 5- self employed
Household head's employment sector	EMPSEC	1- Civilian work 2- Military 3- Private sector 4- Own business
Household head's income	INCOM	1- 3000 SR and less 2- 3001- 5000 SR 3- 5001 – 7000 SR 4- 7001- 9000 SR 5- 9001- 11000 SR 6- 11001-15000 SR 7- 15000 SR and above
No. of cars	CARNO	Real Number
Availability of chauffeur	CHAUFF	0= No 1= Yes
No. of children under 6	UNDER6	Real Number
No. of boys in school	BOYSCH	Real Number
No. of girls in school	GIRLSCH	Real Number
No. of males in work	MALEWORK	Real Number
No. of females in work	FEMWORK	Real Number
Distance to the boys' primary school	DBPS	Real Number
Distance to the girls' primary school	DGPS	Real Number
Distance to mosque	DMOSQUE	Real Number
Distance to CBD	DCBD	Real Number
Distance to work	DWORK	Real Number
Residential density	DENSITY	Real Number

The underlined categories are used as reference categories.

Table 6. 2 Summary statistics of some variables used in the trip generation model.

Variables	Minimum	maximum	Mean	median	mode	Std. Deviation
No. of cars	0	6	1.98	2	1	1.125
No. of children under 6	0	6	1.20	1	0	1.197
No. of boys in school	0	8	1.68	2	0	1.482
No. of girls in school	0	6	1.23	1	0	1.336
No. of males in work	0	6	1.26	1	1	0.840
No. of females in work	0	2	0.21	0	0	0.424
Distance to the boys' primary school (meters)	8	1481	540.29	471.60	420	301.391
Distance to the girls' primary school (meters)	16	1906	569.27	526.57	20	395.759
Distance to mosque (meters)	11	789	284.89	258.62	90	156.423
Distance to CBD (meters)	1456	10554	5585.67	4920.50	3896	2542.497
Distance to work (meters)	935	145000	15804.35	8397.50	125000	22834.005

6.3.1 Applying a Western model to a Saudi context

This section formulates the models and applies the Wootton and Pick model in a Saudi context. Pioneer work, carried out by Wootton and Pick in 1967, was used as a model to test the possibility of adopting a Western model to accommodate a Saudi context. The purpose of this section is to determine to what extent the Western model can be applied to a Saudi context. In their work, Wootton and Pick used six household structure categories, three car ownership categories, and six classes of income. This research intends to follow the same categorisation with slight modification to suit a Saudi household. The Saudi-Western model consists of five household structure categories, three car ownership categories, and seven income classes. Table 6.3 compares variable categorisations in Wootton and Pick's work and this research.

Table 6. 3 Variables used in trip generation model

Variables	Saudi model	Western model (Wootton and Pick)
Household structure	Five household structure types: • No employed residents and two or more non-employed adults (hstruc1) • One employed resident and one or less non-employed adult (hstruc2) • One employed resident and two or more non-employed adults (hstruc3) • Two or more employed residents and one or less non-employed adult (hstruc4) • Two or more employed residents two or more non-employed adults(hstruc5)	Six household structure types: • No employed residents and one non-employed adult • No employed residents and two or more non-employed adults • One employed resident and one or less non-employed adult • One employed resident and two or more non-employed adults • Two or more employed residents and one or less non-employed adult • Two or more employed residents two or more non-employed adults
Car ownership	0, 1, 2+	0, 1, 2+
Income	Seven classes • 3000 SR or less (incom1) • 3001 - 5000 SR (incom2) • 5001 - 7000 SR (incom3) • 7001 - 9000 SR (incom4) • 9001 - 11000 SR (incom5) • 11001 – 15000 SR (incom6) • 15001 SR and above (incom7)	six classes: • less than £500 • £500-less than £1000 • £1000-less than £1500 • £1500-less than £2000 • £2000-less than £2500 • £2500 or more

As can be seen from table 6.3, there is little difference between the variable selected in Wootton and Pick's model and those applied to a Saudi context. Five household structure types are used in the model applied to a Saudi context whereas in Wootton and Pick's model there are six. The household structure type "No employed residents and one non-employed adult" was omitted from the model applied to a Saudi context because the study only covered the travel behaviour of households comprising two or more persons. This was because household consisting of just one unemployed adult are much rare in Saudi Arabia than, for example, the UK. Saudi

household income was categorised into seven income classes in contrast to the six in Wootton and Pick's model, as a result of the greater variation in income range within Saudi household compared to the one proposed by Wootton and Pick for a British households.

The Poisson Regression model is specified in the following form:

$$T_i = \exp(B_0 + B\ hstruc + B\ hstruc + B\ hstruc + B\ hstruc + B\ car_0 + B\ car + B\ incom + B\ incom + B\ incom + B_0\ incom + B\ incom + B\ incom) + \varepsilon_i$$

where T_i= number of car trips per household

B_0= constant, and B_1 to B_{12} are the parameters of the specific variables estimated by the model. ε_i= a Poisson-distributed random error term, one employed resident and two or more non-employed adults (hstruc3), 2+ cars (car2), and income class 4 (incom4), are used as the reference categories.

The P-values were inspected at the 5% significance level. The estimated parameter for most variables had the expected signs. Table 6.4 shows that household structure category number five (two or more employed adults and two or more non-employed adults) was highly significant and household structure category number four (two or more employees and one or no non-employed adult) marginally significant. It be seen that household structure groups of two or more employees tend to be significant, while two categories were insignificant (household structure categories one and two (with only one or no employee). The car ownership categories were highly significant. Three out of six income classes were highly significant, whereas the remaining three were not significant.

Table 6. 4 Parameter estimates and p-values of the PR model, based on Western household categorisation

Variables	coefficient	p-value
Constant	2.3699	**0.0000**
Hstruc1	-0.1065	0.1614
Hstruc2	-0.2452	0.0995
Hstruc4	0.2864	**0.0543**
Hstruc5	0.1698	**0.0000**
Car0	-2.2636	**0.0000**
Car1	-0.5098	**0.0000**
Incom1	-0.4275	**0.0000**
Incom2	0.0186	0.7356
incom3	0.0759	0.1574
Incom5	0.1479	**0.0059**
Incom6	0.0892	0.1469
Incom7	0.2623	**0.0002**
Sample size = 380	Log-L(β)=-1203.777	Log-L (0)= -1465.459

After running the Poisson Regression to estimate the number of car trips generated by a Saudi household using a Western model (Wootton and Pick's model), the study found the selected model explained the variation in trip generation rate to a reasonable degree. Aiming for a better understanding of factors influencing a Saudi household's travel activities, the next step was to run the Poisson Regression model using all the variables related to the household and the head of household, together with the accessibility variables.

6.3.2 Developing a trip generation model for a Saudi context

From the previous section, it can be seen that the results need to be extended to explain all the factors which influence household trip generation in a Saudi context. Therefore, a Poisson regression model was developed to use all variables expected to affect a Saudi household's trip generation rate. Characteristics of the head of the household, household characteristics, and neighbourhood characteristics (i.e. density and accessibility), found associated with car trip rate in the Western context and in this research in a Saudi context, were thus included to produce a more adequate trip

generation model. Table 6.5 presents the variables used in the model. Number of boys in school, number of girls in school, males in employment, females in employment, and the availability of a chauffeur were included to reflect the unique character of the Saudi cultural-social environment.

To measure the influence of distance to workplace of the household head, households with heads who did not perform a work trip at the time of the survey were excluded from the model. This included household heads who were retired, unemployed, on a day off, on holiday, or had no specific workplace (e.g. taxi drivers). Ninety households were excluded (23% of the 380 total household samples), therefore 290 households' details were used in the trip generation model. From table 6.5, it can be seen that characteristics of the household head affected the model. The household head's income and employment sector were significant variables. Household characteristics, namely, car ownership and availability of a chauffeur, were highly significant variables. Number of female employees was highly significant as was the number of children of both genders attending school. The number of children under six years old was significant with a negative sign. Accessibility measures were insignificant, with the exception of distance to work which had a negative sign. Although neighbourhood dummy variables were used, none of these neighbourhoods was significant.

After running a Poisson Regression model using all variables, it was clear that some variables had no significant association with the dependent variable, the household number of car trips. Thus, several Poisson Regression models were estimated omitting the most insignificant variables at each step. This process was repeated until the models contained only significant variables.

Table 6. 5 Parameter estimates and p-values of the PR model, using all variables

Variables	coefficient	p-value
Constant	2.3036	**0.0033**
Khalej	-0.3282	0.0797
Jamen	-0.4310	0.2973
Ghornat	-0.2467	0.2909
Roabi	-0.4242	0.1159
Aziziah	-0.3023	0.3490
Petromin	-0.5558	0.0797
Illeter	-0.1146	0.3318
Primary	-0.0526	0.4926
Interm	-0.0066	0.9149
Techni	0.0066	0.9419
Univ	-0.0776	0.1877
Post	0.0669	0.7060
Admin	0.0194	0.7066
Bussines	0.0011	0.9922
Workman	0.0671	0.4852
Other	0.1480	0.3538
Civil	0.1402	**0.0098**
Military	-0.0803	0.3061
Ownbus	0.3025	0.0159
Incom1	-0.3137	**0.0077**
Incom2	0.0242	0.7380
Incom3	0.1806	**0.0076**
Incom5	0.1390	**0.0415**
Incom6	0.1217	0.1092
Incom7	0.2982	**0.0020**
Carno	0.1339	**0.0000**
Chauff	0.2742	**0.0000**
Under6	-0.0391	**0.0372**
Boysch	0.0440	**0.0013**
Girlsch	0.0392	**0.0099**
Malework	0.0538	0.0778
Femwork	0.2022	**0.0000**
Density	-0.0021	0.2870
Dcbd	0.0003	0.9948
Dmosque	-0.0250	0.8595
Dbps	-0.0424	0.6336
Dgps	-0.0372	0.6274
Dwork	-0.0023	**0.0273**
Log-L(β)	-819.094	
Log-L (0)	-1081.972	
Sample size	290	

See table 6.1 for variables' details.

Table 6.6 reveals the final model, containing only significant variables. These variables can be classified as follows:

a) Household head's characteristics: a household head's working sector is significant. A household head working in a civil sector, where there is less restriction on travel within working hours, tends to produce more car trips. A household head who works in his own business tends to produce significantly more car trips presumably due to his ability to change his timetable to serve household members' travel needs. Household head's income is another significant variable. Households whose heads have an income of less than 3000 SR tend to perform fewer car trips than households whose heads have a higher income.

b) Household characteristics: car ownership, number of children attending school, and availability of a chauffeur all positively influence trip rate. On the other hand, number of pre-school children under 6 years old negatively influenced the number of car trips generated. This finding is consistent with that of Jones, et al. (1983) who reported that the existence of children under school age restricts the participation of those taking care of children from performing out-of-home activities.

c) Neighbourhood and accessibility characteristics: residential density of neighbourhood (population/ area) was a significant variable with a negative sign. As residential density increases, car trip rate decreases. Similarly, accessibility to work (distance to work) was a significant variable with a negative sign. As the distance to the head's workplace increases, car trips generated to serve other household members' needs are likely to decrease. A household head working a short distance from home tends to serve passengers' needs on his way to work or within his working hours, whereas a household head whose workplace is far from his home cannot participate in such activities to the same extent. It is important to note that β parameters are not

directly interpretable as marginal effects as they are in a linear regression model. What can be done is to interpret the ratio of pairs of β parameters (Louviere et al, 2000). It is important to indicate that preliminary analysis of the trip generation data suggests the existence of overdispersion (the variance is greater than the mean), suggesting the application of a negative binomial model in future research.

Table 6. 6 Parameter estimates, and p-values of the PR model

Variables	coefficient	p-value
Constant	1.782	0.0000
Civil	0.1556	0.0004
Ownbus	0.3066	0.0000
Incom1	-0.4247	0.0000
Incom3	0.1103	0.0317
Incom7	0.2276	0.0010
Carno	0.1573	0.0000
Chauff	0.2814	0.0000
Under6	-0.0423	0.0121
Chsch	0.0431	0.0000
femwork	0.1924	0.0000
Density	-0.6560	0.0049
Dwork	- 0.0025	0.0076
Log-L(β)	-836.556	
Log-L (0)	-1081.972	
Sample size	290	

6.4 Summary

This chapter has discussed the trip generation model undertaken to identify the factors influencing trip generation in a Saudi context. At the beginning, a trip generation model in a Saudi context was applied using Western model specifications. Wootton and Pick's model was applied to a Saudi context with minor modifications made to categories to reflect the Saudi context. The model provided an initial explanation of the factors influencing trip generation in Saudi households. Seeking more investigation of socio-economic characteristics and neighbourhood and accessibility attributes, a model for trip generation in a Saudi context was developed.

As expected, factors such as car ownership, income, number of employees, number of children attending school, and head's working sector were found to positively influence the number of car trips generated by a household.

Neighbourhood density and the household head's access to his workplace, in terms of distance, were both significant variables in the trip generation model with a negative sign. The following chapter will discuss the characteristics of work journey and the specification and results of journey to work tour type modelling.

CHAPTER SEVEN

Analysis of work-tour characteristics and types

7.1 Introduction

This chapter endeavours to identify factors influencing the household head's selection of a particular work tour, i.e. simple to work, complex to work, complex from work, and complex to and from work. The work tour type depends on the number of tour legs and the sequence of secondary stops, before or after work (see Chapter Three, section 3.3.2, for more details). A tour based model is used because one of the study's objectives is to explore the influence of household members' activities on household travel pattern. Therefore, it is necessary to study the link between trips using a tour based model rather than a trip based model (see Chapter Three, Section 3.3.2, for more details). A tour is defined as a work tour if it involves a stop for work purposes, even if the tour contains other stops for other purposes. As long as the tour involves a stop at work it is defined as a work tour. As has been shown in Chapter Five, Section 5.2.3, 18% of all household travel activities by all travel modes are classified as work tours and 30.9% of all car tours were categorised as work tours.

Section 7.2 descriptively analyses work tour characteristics, presenting statistics relating to tour type, tour time, tour mode, number of trip legs, activities linked to work-tours, and number and type of passengers. Section 7.3 compares work-tours according to tour traveller, i.e. household head versus others. Section 7.4

introduces factors assumed to influence the household head's work tour. As in the trip rate model, these include household head characteristics, household socio-economic characteristics, and neighbourhood attributes. Section 7.4 specifies the Multinomial Logit model used to identify significant factors influencing work-tour type, and section 7.5 details the statistical results. Finally, section 7.6 summarises the chapter's contents.

7.2 Characteristics of work tours

In the activity based literature, travel studies have examined the travel pattern associated with the commute to work. The major motivation for focusing on workers' travel is the significant effect commuting to work has on peak traffic congestion (Bhat and Gossen, 2004). Due to the importance of work tours, which are the main reasons for car tours, this section will present a descriptive analysis of work tour attributes. Work tours are defined as tours performed by adult males whose main purpose is the commute from home to work. Tours which include giving a lift to a household member from home to work or from work to home are not classified as work tours. These are viewed as lifts given to drop off or pick up a household member to/from work.

7.2.1 Work tour type

Most work tours were simple (69.2%), but when compared with non-work tours, work tours were more complex due to several reasons. First, work tours are usually performed during peak hours when household members' travel needs are high. Second, adult males are committed to serving the needs of passengers within the household. The household head may need to seek permission to leave his place of employment within working hours to drive his children home from school or his wife home from her place of employment. The timing of tour stops gives an indication of

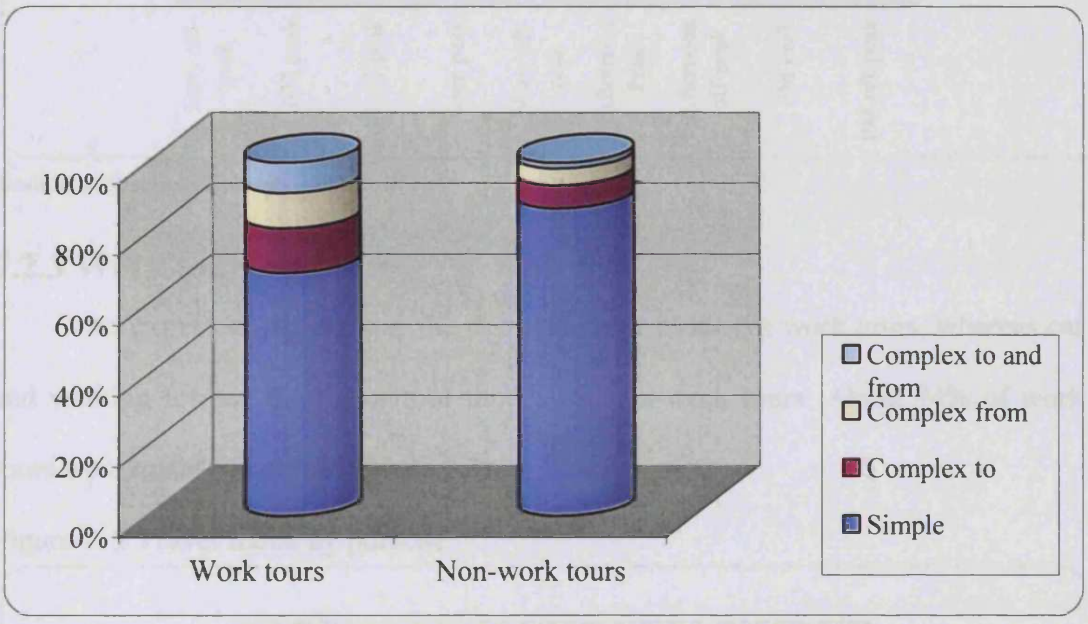
travel needs. As can be seen from Table 7.1 and Figure 7.1, most stops occurred on the household head's way to work (in order to serve a passenger).

Table 7. 1 Work tour type

Tour Type	Frequency	Percentage
Simple	346	69.2
Complex to	57	11.4
Complex from	51	10.2
Complex to and from	46	9.2
Total	500	100

Source: Household Survey, 2003.

Figure 7. 1 Tour type by purpose



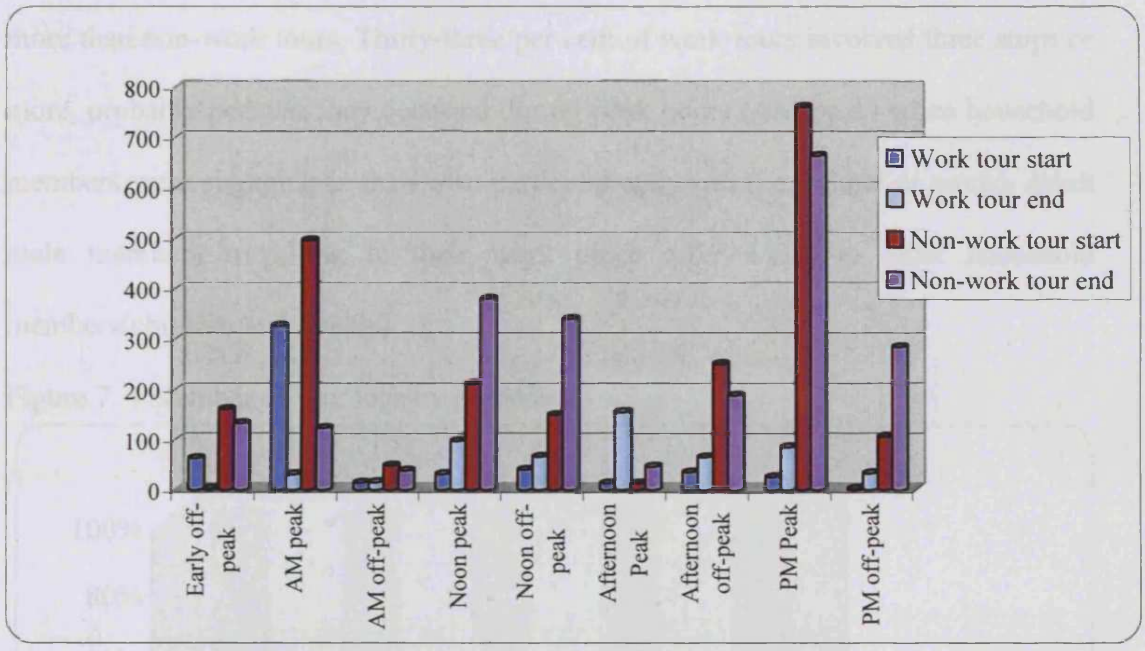
Source: Household Survey, 2003.

7.2.2 Work tour timing

As expected, the majority of work tours took place in the morning peak hours (6:30-8:00 am). As can be seen from Figure 7.2, morning peak hours are the busiest traffic generating period and work tours formed 88% of tour types starting during this period. Their end time, on the other hand, occurred during a period of less traffic

congestion periods. Most non-work tours took place predominantly in evening peak hours.

Figure 7. 2 Tours' start and end periods

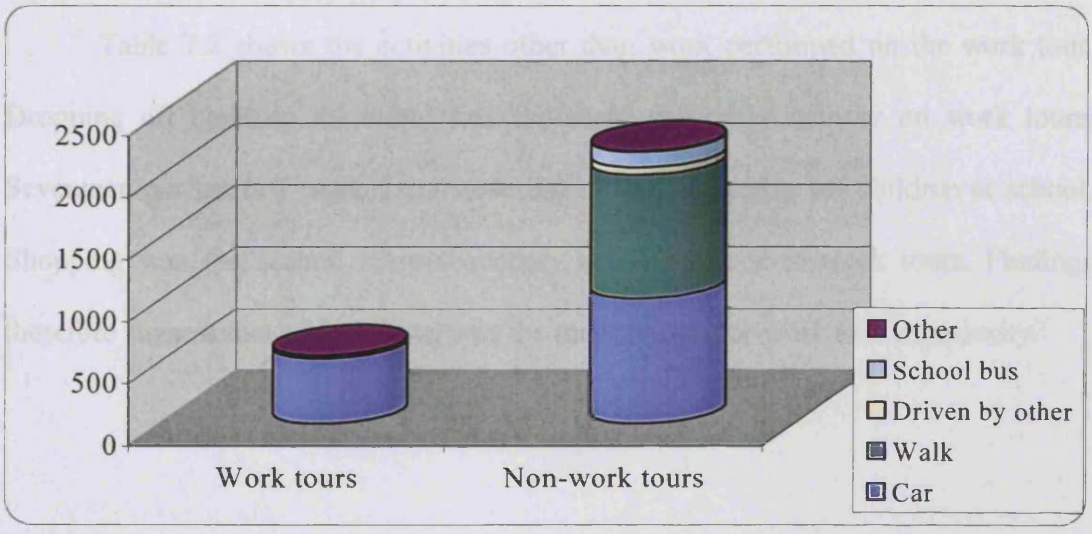


Source: Household Survey, 2003.

7.2.3 Work tour mode

As expected, the car was the dominant tour mode for work tours, whereas car and walking formed the major tour modes for non-work tours. About 94% of work tours were made by car (see Figure 7.3).

Figure 7. 3 Travel mode by purpose

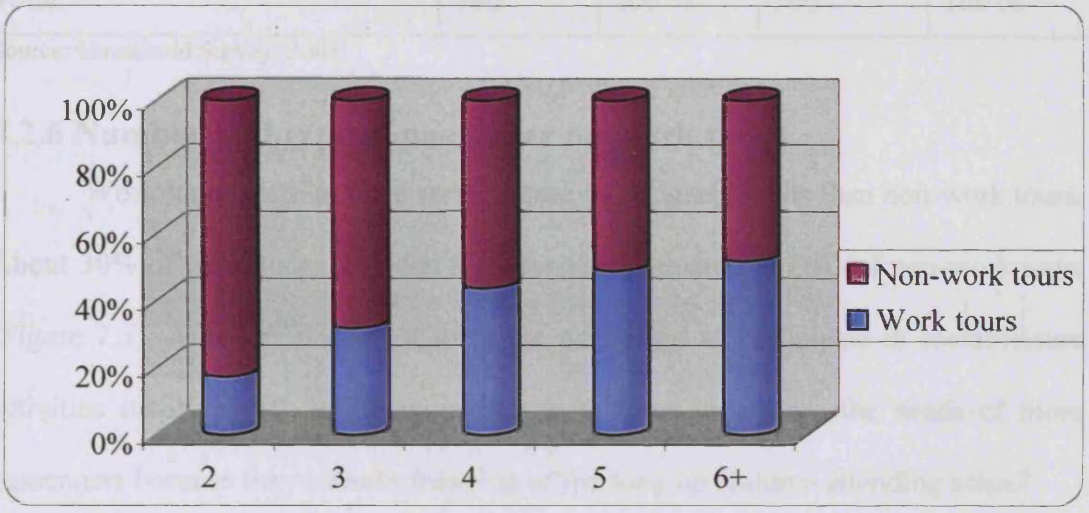


Source: Household Survey, 2003.

7.2.4 Number of trip legs

Work tours involved more stops than non-work tours, reflecting their greater complexity. As can be seen from Figure 7.4, work tours involved in complex tours more than non-work tours. Thirty-three per cent of work tours involved three stops or more, probably because they occurred during peak hours (AM peak) when household members were engaging in their own particular activities (i.e. school or work). Adult male members travelling to their work place offer a lift to other household members(children and female).

Figure 7. 4 Number of tour legs by purpose



Source: Household Survey, 2003.

7.2.5 Activities linked to work-tours

Table 7.2 shows the activities other than work performed on the work tour. Dropping off children at school was the main secondary activity on work tours. Seventeen per cent of work tours were linked with dropping off children at school. Shopping was the second main secondary activity linked to work tours. Findings therefore suggest that school travel was the main reason for work tour complexity.

Table 7. 2 Activities performed during to work tours

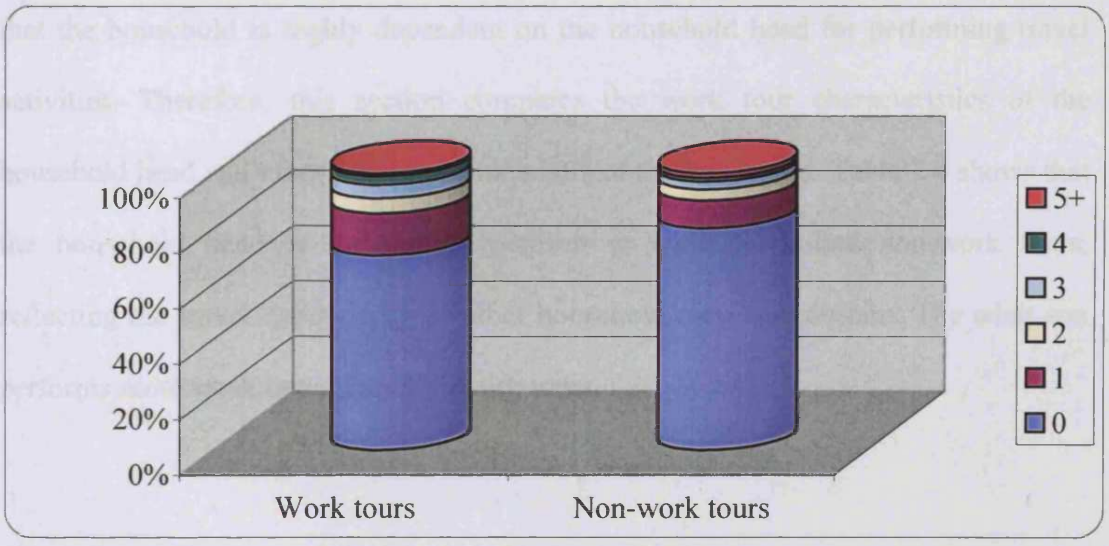
Activities	First secondary stop		Second secondary stop	
No stop	338	69.2 %	418	83.6 %
Dropping off a member at school	85	17 %	42	8.4 %
Picking up a member from school	10	2 %	14	2.8 %
Shopping	34	6.8 %	12	2.4 %
Spiritual	4	0.8 %	2	0.4 %
Social/leisure	5	1 %	2	0.4 %
Personal Business	12	2.4 %	4	0.8 %
Dropping off a member at work	11	2.2 %	2	0.4 %
Picking up a member from work	1	0.2 %	4	0.8 %
Total	500	100 %	500	100 %

Source: Household Survey, 2003.

7.2.6 Number and type of passenger on work tours

Work tours seem to have served more passengers' needs than non-work tours. About 30% of work tours included a passenger, compared to 20% of non-work tours (Figure 7.5). Although non-work tours are performed to participate in social/leisure activities involving all family members, work tours still serve the needs of more passengers because they include dropping off/picking up children attending school.

Figure 7. 5 Tours' passengers by purpose



Source: Household Survey, 2003.

As explained in section 7.2.4, school was the main secondary stop on work tours. Children attending school made up 81% of all work tour passengers. Table 7.3 shows that almost three-quarters (72%) of work tours served the needs of female passengers, reflecting the lack of transport alternatives for females, their travel dependency on male household members, and their dependency contribution to the complexity of work tours.

Table 7. 3 Work tour passengers

Passenger type	Frequency	Percentage
Boys in school	24	20.8 %
Girls in school	37	32.1 %
Boys and girls in school	26	22.6 %
Wife	13	11.3 %
Boys and/or girls in school and wife	7	6 %
Other	8	6.9 %
Total	163	100 %

Source: Household Survey, 2003.

7.3 Household members participating in work tours

Section 7.2 has provided a general picture of the characteristics of work tours. This section compares work-tours by tour traveller. One of the study's assumptions is that the household is highly dependent on the household head for performing travel activities. Therefore, this section compares the work tour characteristics of the household head and other adult male members of the household. Table 7.4 shows that the household head is the person performing most work and non-work tours, reflecting the travel dependency of other household members on him. The adult son performs more work tours than non-work tours.

Table 7. 4 Tour travellers

Tour traveller	Work tours (%)	Non-work tours (%)
Household Head	71.2	48.6
Adult son	22.4	17.8
Other	6.4	33.6
Total	100%	100%

Source: Household Survey, 2003.

7.3.1 Travel complexity by traveller

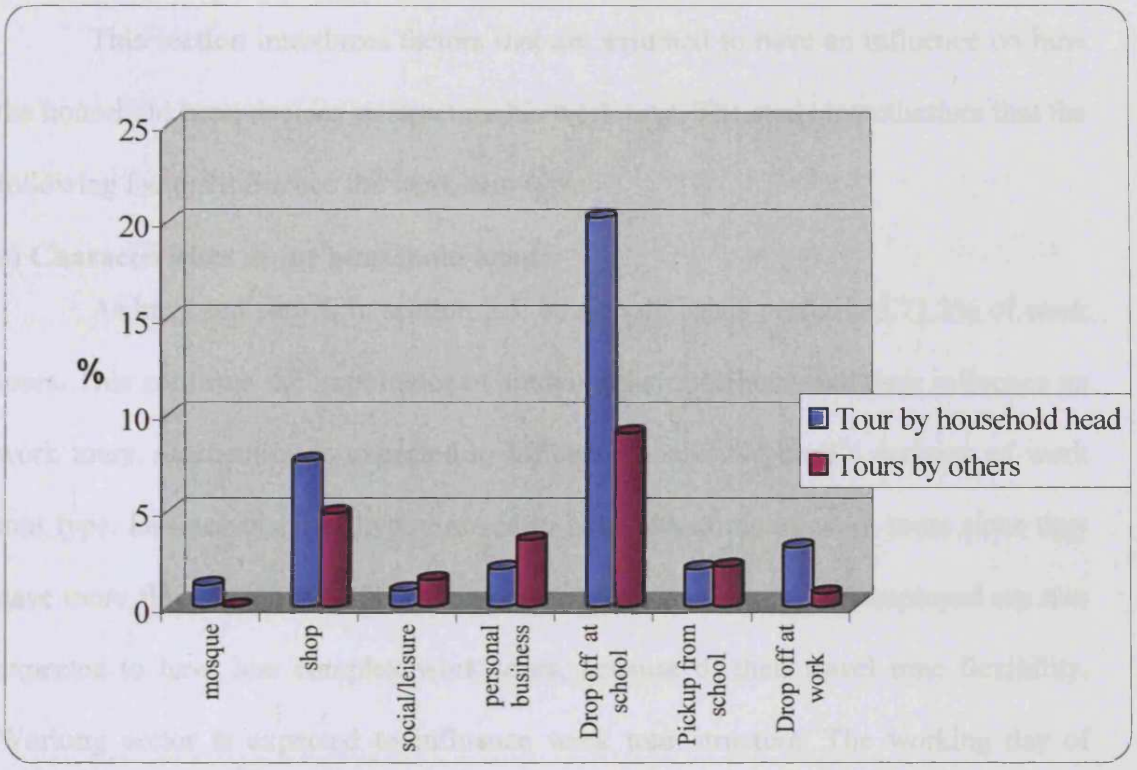
Work-tours performed by the household head tended to involve more stops. Table 7.5 shows more than 37% of work tours performed by household heads involved three trip legs or more. On the other hand, only 23% of work tours performed by other household members involved more than two trip legs. This shows the commitment of the household head to serving other household members' travel needs. Moreover, although other adult male household members are travelling at the same time, it is the household head who performs the most complex tours, particularly those whose first stop is dropping children off at school as shown in Figure 7.6.

Table 7. 5 Tour legs by traveller

Number of work-tour legs	Work-tours by household head (%)	Work-tours by others (%)
2	62.9	78.5
3	17.1	9.7
4	10.7	9.0
5	6.2	0.7
6 +	3.1	2.1
Total	100%	100%

Source: Household Survey, 2003.

Figure 7. 6 Work-tour's first stop purpose by traveller



Source: Household Survey, 2003.

7.3.2 Tour Type by tour traveller

Table 7.6 indicates that household heads tend to perform complex tours on their way to work. In contrast, other workers stop more frequently on their way home from work. The findings highlight the travel complexity of the household head who takes the main responsibility for serving the travel needs of those who do not have access to a car, i.e. children and females.

Table 7. 6 Work tour types

Tour Type	Household Head (%)	Other adult male (%)
Simple	64.9	79.5
Complex to	14.0	4.9
Complex from	10.4	9.7
Complex to and from	10.7	5.6
Total	100	100

Source: Household Survey, 2003.

7.4 Factors influencing the work-tour of the household head

This section introduces factors that are assumed to have an influence on how the household head decides to structure his work tour. The study hypothesises that the following factors influence the work-tour type:

a) Characteristics of the household head

As has been shown in section 7.3, household heads performed 71.2% of work tours. This confirms the importance of studying their attributes and their influence on work tours. Occupation is expected to influence household head's decision of work tour type. Businessmen are hypothesised to have less complex work tours since they have more flexible working hours than others. People who are self-employed are also expected to have less complex work tours, because of their travel time flexibility. Working sector is expected to influence work tour structure. The working day of household heads employed in the Civil Service commences at 7:30 am and ends at 2:30 pm. Their working hours are more flexible, hence they can ask permission to leave within working hours to give lifts to household members. In contrast, household heads who work in the military sector have very restricted working hours. They start early in the morning, about 6:00 am, which means they are unable to give lifts to household members attending school. The household head's income is also assumed to have an influence on the structure of work tours. Those in low income groups are expected to perform more complex tours than high income groups, because low income households are associated with low car ownership, hence, the household head will have to perform more car trips to fulfil other household members' travel needs. Further, household heads in high income groups can afford to recruit a chauffeur, an option not available to those in low income groups.

b) Household characteristics

Household attributes are expected to be main determinants of work tour type. Factors such as household car ownership, the availability of a chauffeur, number and gender of children attending school, number of females in employment, and family size have an influence on work tour type. An increase in the number of children attending school increases the complexity of a work tour. Because of the Saudi cultural environment, which constrains females' movements, the study assumes students' gender will influence tour type, i.e. a household head with a daughter who is a student is more likely to participate in a complex work tour than a head with a son who is a student. A household head with a female in employment is more likely to engage in stops during his work tour to give her a lift to/from her workplace than one with a male member in employment. This is due to female members' greater travel dependency on the household head.

c) Residential area characteristics

Neighbourhood attributes include residential density and services distribution, while accessibility measures include: distance to the Central Business District (CBD), distance to the nearest mosque, distance to boys' primary schools, distance to girls' primary schools, and distance to the household head's workplace. Residents in high density areas are assumed to have less tour complexity than those in low density areas, due to neighbourhood design, and the availability of services. Accessibility or distance to the workplace is another important factor. Distance to the household head's workplace is used to measure his accessibility to his job, as he is the person most involved in complex tours. A household head whose workplace is near his home is likely to be involved in complex work tours, especially complex mid-day tours when he leaves his workplace during working hours to pick up household members from work/school, take them home, and then return to his workplace. However, as

distance to work increases, the household head is less likely to be involved in complex tours. School is one of the most popular stops on work tours, therefore, as the distance between home and school increases, the probability of a complex work tour increases, especially if there are male and female students in the household.

7.5 Modelling Work-tour type

A Multinomial Logit (MNL) model is used to analyse the household head's choice of tour type and factors influencing his choice. This section describes the modelling procedure and how the MNL model is used to identify factors influencing the work-tour type of the household head (see Chapter Three, Section 3.3.2, for more details about MNL model).

The dependent variable is the probability of selecting a particular work-tour type from four tour types: simple to work, complex to work, complex from work , and complex to and from work. The explanatory variables consist of the household head's attributes (educational level, occupation, employment sector, and income), household socio-economic characteristics (car ownership, availability of a chauffeur, number of boys attending school, number of girls attending school, and number of females in employment), and neighbourhood characteristics (residential density, distance to boys' primary school, distance to girls' primary school, and distance to the CBD). Table 7.7 shows the different categories assigned to each variable in the MNL model.

Table 7. 7 Variables used in the Multinomial Logit model

Dependent Variable	Variable name	Categories
Dependent Variable Work tour type	TTYPE	1- Simple 2- Complex to 3- Complex from 4- Complex to and from
Explanatory Variables	Variable name	Categories
Neighbourhood	NID	1= Khaleej, 2= Jamayyen, 3= Iscan 4= Gharnata, 5= Al-Roabi, 6= Al-Aziziah, 7= Petrumin
Household head's level of education	EDUC	1- Illiterate 2- Can read and write 3- Primary school 4- Intermediate school 5- Secondary school 6- Technical institute 7- University graduate 8- Postgraduate
Household head's Occupation	OCCU	1- Professional 2- Administrative 3- Businessman 4-Workman 5- self employed
Household head's employment sector	EMPSEC	1- Civilian work 2- Military 3- Private sector 4- Own business
Household head's income	INCOM	1- 3000 SR and less 2- 3001- 5000 SR 3- 5001 – 7000 SR 4- 7001- 9000 SR 5- 9001- 11000 SR 6- 11001-15000 SR 7- 15000 SR and above
No. of household members	HSIZE	1)- 2 to 5 2)- 6 to 7 3)- 8 to 9 4)- 10 and more
Availability of a chauffeur	CHAUFF	0= No 1= Yes
No. of cars	CAR	1- one car or no car 2- two cars 3- three cars or more
No. of Boys in school	BOYSCH	Real number
No. of girls in school	GIRLSCH	Real number
No. of females in work	FEMWORK	Real number
Distance to boys' primary school	DBPS	Real number
Distance to girls' primary school	DGPS	Real number
Distance to CBD	DCBD	Real number
Distance to work	DWORK	Real number
Residential density	DENSITY	Real number

The underlined categories are used as reference categories.

7.5.1 Specification of the Multinomial Logit model

The purpose of this section is to specify the model used in the analysis. The general form of the equations for the MNL with simple tours as the reference tour category model is:

$$LN\left(\frac{t_{complexto}}{t_{simple}}\right) = B_0^{complexto} + B_1^{complexto} Educ_1 + B_2^{complexto} Educ_2 + B_3^{complexto} Educ_3 + B_4^{complexto} Educ_4$$
$$+ B_5^{complexto} Educ_6 + B_6^{complexto} Educ_7 + B_7^{complexto} Occu_2 + B_8^{complexto} Occu_3 + B_9^{complexto} Occu_4$$
$$+ B_{10}^{complexto} Occu_5 + B_{11}^{complexto} emp\sec_1 + B_{12}^{complexto} emp\sec_2 + B_{13}^{complexto} emp\sec_4 + B_{14}^{complexto} Incom_1$$
$$+ B_{15}^{complexto} Incom_2 + B_{16}^{complexto} Incom_3 + B_{17}^{complexto} Incom_5 + B_{18}^{complexto} Incom_6 + B_{19}^{complexto} Incom_7$$
$$+ B_{20}^{complexto} Car_2 + B_{21}^{complexto} Car_3 + B_{22}^{complexto} Girlsch + B_{23}^{complexto} Boysch + B_{24}^{complexto} Hsize_2 +$$
$$B_{25}^{complexto} Hsize_3 + B_{26}^{complexto} Hsize_4 + B_{27}^{complexto} Chauff_1 + B_{28}^{complexto} DBPS + B_{29}^{complexto} DGPS$$
$$+ B_{30}^{complexto} DCBD + B_{31}^{complexto} DWORK + B_{32}^{complexto} Density + B_{33}^{complexto} Khalej$$
$$+ B_{34}^{complexto} Jamayyen + B_{35}^{complexto} Gharnat + B_{36}^{complexto} Aziziah + B_{37}^{complexto} Petro \min$$

$$LN\left(\frac{t_{compexfrom}}{t_{simple}}\right) = B_0^{complexfrom} + B_1^{complexfrom} Educ_1 + B_2^{complexfrom} Educ_2 + B_3^{complexfrom} Educ_3 +$$
$$B_4^{complexfrom} Educ_4 + B_5^{complexfrom} Educ_6 + B_6^{complexfrom} Educ_7 + B_7^{complexfrom} Occu_2 + B_8^{complexfrom} Occu_3$$
$$+ B_9^{complexfrom} Occu_4 + B_{10}^{complexfrom} Occu_5 + B_{11}^{complexfrom} emp\sec_1 + B_{12}^{complexfrom} emp\sec_2$$
$$+ B_{13}^{complexfrom} emp\sec 4 + B_{14}^{complexfrom} Incom_1 + B_{15}^{complexfrom} Incom_2 + B_{16}^{complexfrom} Incom_3$$
$$+ B_{17}^{complexfrom} Incom_5 + B_{18}^{complexfrom} Incom_6 + B_{19}^{complexfrom} Incom_7 + B_{20}^{complexfrom} Car_2$$
$$+ B_{21}^{complexfrom} Car_3 + B_{22}^{complexfrom} Girlsch + B_{23}^{complexfrom} Boysch + B_{24}^{complexfrom} Hsize_2 + B_{25}^{complexfrom} Hsize_3$$
$$+ B_{26}^{complexfrom} Hsize_4 + B_{27}^{complexfrom} Chauff_1 + B_{28}^{complexfrom} DBPS + B_{29}^{complexfrom} DGPS$$
$$+ B_{30}^{complexfrom} DCBD + B_{31}^{complexfrom} DWORK + B_{32}^{complexfrom} Density + B_{33}^{complexfrom} Khalej$$
$$+ B_{34}^{complexfrom} Jamayyen + B_{35}^{complexfrom} Gharnata + B_{36}^{complexfrom} Aziziah + B_{37}^{complexfrom} Petro \min$$

$$LN\left(\frac{t_{compto+from}}{t_{simple}}\right) = B_0^{compto+from} + B_1^{compto+from} Educ_1 + B_2^{compto+from} Educ_2 + B_3^{compto+from} Educ_3$$
$$+ B_4^{compto+from} Educ_4 + B_5^{compto+from} Educ_6 + B_6^{compto+from} Educ_7 + B_7^{compto+from} Occu_2$$
$$+ B_8^{compto+from} Occu_3 + B_9^{compto+from} Occu_4 + B_{10}^{compto+from} Occu_5 + B_{11}^{compto+from} emp\sec_1$$
$$+ B_{12}^{compto+from} emp\sec_2 + B_{13}^{compto+from} emp\sec 4 + B_{14}^{compto+from} Incom_1 + B_{15}^{compto+from} Incom_2$$
$$+ B_{16}^{compto+from} Incom_3 + B_{17}^{compto+from} Incom_5 + B_{18}^{compto+from} Incom_6 + B_{19}^{compto+from} Incom_7$$
$$+ B_{20}^{compto+from} Car_2 + B_{21}^{compto+from} Car_3 + B_{22}^{compto+from} Girlsch + B_{23}^{compto+from} Boysch$$
$$+ B_{24}^{compto+from} Hsize_2 + B_{25}^{compto+from} Hsize_3 + B_{26}^{compto+from} Hsize_4 + B_{27}^{compto+from} Chauff_1$$
$$+ B_{28}^{compto+from} DBPS + B_{29}^{compto+from} DGPS + B_{30}^{compto+from} DCBD + B_{31}^{compto+from} DCBD$$
$$+ B_{32}^{compto+from} Density + B_{33}^{compto+from} Khalej + B_{34}^{compto+from} Jamayyen + B_{35}^{compto+from} Gharnata$$
$$+ B_{36}^{compto+from} Aziziah + B_{37}^{compto+from} Petro \min$$

Where:

$B_0^{complexto}, B_0^{Complexfrom}, and B_0^{Compto+from}$ are parameters of the tour type constants, and B_1 to B_{37} are parameters of specific variables estimated by the model. See table 7.7, for categories used as reference categories.

The analysis is undertaken using the LIMDEP 7 for Windows software package, which has the ability to run a discrete choice MNL model directly.

7.5.2 Estimation of Multinomial Logit models for work-tour type

The MNL model was run using all 15 variables presented in table 7.7. Household head's occupation, household size, car ownership, availability of a chauffeur, and existence of female employees were found to be significant. Table 7.8 presents the estimated coefficients and p-values of all explanatory variables of a household head's work-tour type at the 5 % significance value. Many variables were found to have no significant association with work-tour type, partly attributable to the detailed categorisation of some variables (occupation, education, income and household size). Some non-significant variables were therefore omitted and others grouped into broader categories. This process was repeated until the models contained significant variables only. Additionally, some variables, which had several different categories and were insignificant, were regrouped as follows:

a) The educational level variable (Edu): most educational categories did not significantly influence tour type, therefore, the eight general categories were regrouped into two: low education and high education. The former, low education, comprised the categories illiterate, can read and write, primary school, intermediate school, and secondary school, while the latter, high education, included technical institute, university graduate, and postgraduate. Low education category was used as a reference category.

Table 7. 8 MNL model parameter estimates all explanatory variables of household head's tour type

Variable	Prob{Y=complex to} in numerator		Prob{Y=complex from} in numerator		Prob{Y=complex to+from} in numerator	
	coefficient	p-value	coefficient	p-value	coefficient	p-value
CONSTANT	8.6852	0.2034	-11.2060	0.1542	9.7675	0.2438
KHALEJ	-2.8848	0.1124	1.6701	0.4296	-1.9702	0.3591
JAMEN	-4.5317	**0.0436**	1.0589	0.6623	-3.4559	0.1842
GHORNAT	-1.8933	0.1976	1.6410	0.3194	-1.4864	0.3942
AZIZIAH	-2.5632	0.2361	3.0393	0.2367	-2.3365	0.3882
PETROMIN	-0.8332	0.4063	-0.1353	0.9262	0.0696	0.9580
EDUC1	-0.4700	0.6857	0.5604	0.5897	-30.7452	1.0000
EDUC2	-0.0148	0.9844	-1.3369	0.3232	-0.8622	0.5051
EDUC3	-0.2266	0.7122	0.5829	0.4500	-2.1488	0.1199
EDUC4	-0.5720	0.5244	-0.3294	0.6365	-0.0131	0.2148
EDUC6	-0.5586	0.3772	-1.3378	0.2670	-0.0253	0.9795
EDUC7	-32.6709	1.0000	0.2372	0.7057	-0.0196	0.9774
EDUC8	-32.4743	0.000	-31.9906	1.0000	-32.7978	1.0000
OCCUP2	-1.1095	**0.0354**	-0.8731	0.1517	-0.6815	0.2226
OCCUP3	-2.9676	**0.0179**	-0.5546	0.6094	-0.8489	0.5598
OCCUP4	-0.1032	0.8934	-0.5462	0.5588	0.2330	0.8626
OCCUP5	-1.4204	0.0695	-0.1863	0.8264	-1.6152	0.0930
EMPSEC1	-0.3295	0.5203	0.1603	0.7796	0.9202	0.1047
EMPSEC2	-0.2097	0.7538	-0.0860	0.9017	0.3746	0.6519
EMPSEC3	0.1438	0.8981	-0.8635	0.4164	-1.8209	0.3161
INCOM1	-0.1408	0.8917	-1.5597	0.2184	0.2975	0.8099
INCOM2	0.5173	0.4599	-0.6896	0.3514	0.1671	0.8389
INCOM3	-0.3915	0.5793	0.1799	0.7783	-0.7940	0.3239
INCOM5	1.0594	0.1413	-0.1488	0.8215	-0.2351	0.7857
INCOM6	1.1047	0.1343	-1.6327	0.1798	-0.0872	0.9251
INCOM7	0.8848	0.4484	-0.6117	0.6499	-0.8716	0.5229
CHAUFF	-1.5679	**0.0256**	0.3804	0.6913	-1.3543	0.1003
CAR2	-0.5511	0.2181	0.6304	0.2196	0.2259	0.6443
CAR3	-2.1273	**0.0005**	0.3401	0.5374	-2.7056	**0.0017**
GIRLSCH	0.3449	**0.0296**	0.1254	0.4829	0.1650	0.4118
BOYSCH	0.0046	0.9743	-0.1273	0.4239	0.0083	0.9584
FEMWORK	1.1932	**0.0092**	-0.3625	0.5205	1.3744	**0.0099**
HSIZE2	0.6776	0.1922	-0.3279	0.5565	1.0563	0.0652
HSIZE3	1.4779	**0.0049**	0.1914	0.7427	0.9177	0.1726
HSIZE4	0.4757	0.4032	0.3734	0.5303	0.3860	0.6118
DBPS	-0.0015	0.1191	0.0021	**0.0341**	0.0012	0.2557
DGPS	0.0005	0.5142	0.0007	0.3949	-0.1483	0.1204
DCBD	-0.0007	0.1893	0.0007	0.2072	-0.0009	0.1606
DWORK	-0.0044	0.5927	-0.0387	0.1505	-0.0544	0.0658
DENSITY	-0.0249	0.0943	0.0202	0.2389	-0.0282	0.1249
Sample size		349				
Log-L(B)		-267.35		Log-L_0		-356.78

b) Head's income: the income variable was initially categorised as 7 income groups. These groups were subsequently combined into two categories, 7000 SR and less, and 7001 SR and above. The latter was used as a reference category.

c) Household's car ownership: the three car ownership categories were combined into two categories: two or fewer cars (reference category), and three or more cars.

d) Household size: the four household size categories were regrouped into two categories: household of 7 persons or less (reference category), and 8 persons or more.

Final model results are presented in table 7.9. Household heads in Jamayen tended to perform less complex work tours than those in other neighbourhoods. This may be due to two reasons. Far more households in Jamayen hired a chauffeur to escort children and female members to their destination, than those in other neighbourhoods, and possibly because the majority of household heads in Jamayen worked in the private sector, which has strict working hours, which in turn prevents the household head from participating in serving passengers' travel needs on his way to and from his workplace. Household heads with a higher education level were less likely than others to engage in complex work-tours, again probably because of being in a high income group and able to hire a chauffeur. Moreover, businessmen owning their own businesses can pay and arrange for others to serve their household members' travel needs. Heads in administration were more likely than those in other occupations to stop on their way home from work. Households using a chauffeur were less likely to engage in complex tours to work. An increase in the number of female students in a household increased the probability of complex tours to work, as female

students depend on lifts given by household heads due to lack of adequate and reliable school bus services.

Distance to work was found to be significant in the "complex to and from" tour type, implying that increase in distance travelled to work decreases the probability of involvement in complex to and from work tours.

The coefficients in the MNL model are difficult to interpret directly (Greene, 2003). They are not simply marginal effects as they are in a linear regression model.

Table 7. 9 MNL parameter estimates using significant variables only.

Variable	Prob{Y=complex to} in numerator		Prob{Y=complex from} in numerator		Prob{Y=complex to+from} in numerator	
	coefficient	p-value	coefficient	p-value	coefficient	p-value
Constant	-2.1893	**0.0018**	-1.1110	0.1093	-0.4668	0.5188
Jamen	-1.4392	**0.0360**	-1.2880	0.0699	-0.5942	0.3955
Occup2	-1.0109	**0.0259**	-1.2460	**0.0155**	-0.2671	0.5325
Occup3	-2.5158	**0.0065**	-1.2398	0.0675	-1.5663	0.0573
Educg2	-1.4764	**0.0366**	-0.8827	0.1769	-1.1138	0.1082
Incomg1	1.9699	**0.0000**	1.1336	**0.0061**	0.1656	0.6743
Chauff	-1.4298	**0.0234**	-0.3192	0.5958	-1.4996	**0.0216**
Carg3+	-2.5635	**0.0000**	-0.4379	0.3516	-2.6284	**0.0009**
Girlsch	0.6499	**0.0001**	0.1791	0.3163	0.4772	**0.0074**
femwork	1.2854	**0.0043**	-0.2381	0.6412	1.2729	**0.0032**
Hsizeg2	2.2073	**0.0000**	1.2492	**0.0040**	0.2629	0.5643
DWORK	-0.0030	0.6837	-0.0325	0.1229	-0.0492	**0.0415**
Density	-0.0080	**0.0019**	-0.0050	0.053	-0.0049	0.0615
Sample size		349				
Log-L(B)		-279.76		Log-L_0		-356.78

7.6 Summary

This chapter has discussed the characteristics of work tour types. The descriptive analysis of the work-tour revealed work tours were usually performed in peak hours when household members' travel needs are high. As expected, work tours

were performed by car as the dominant travel mode. Most work tours were simple (69.2%). The most frequent purpose for secondary stops in complex work tours was to drop children off at school. In addition, the analysis of work tour type supported the assumption "Saudi households depend highly on the household head for performing their travel activities", since findings revealed children attending school and females in employment were highly dependent on the household head to fulfil their travel needs.

The MNL model revealed household heads' work tour types were significantly influenced by three factors: household heads' characteristics (i.e. occupation, education, and income), household socio-economic characteristics, namely, car ownership, availability of a chauffeur, number of female students, number of females in employment, and household size; and neighbourhood and accessibility attributes, i.e. residential density and distance to work. The following chapter presents the results of in-depth interviews to identify the constraints that may influence a household's travel decisions.

CHAPTER EIGHT

Understanding Household Travel Decisions

8.1 Introduction

Chapters five, six and seven accomplished the first objective of this study, to analyse Saudi households' travel behaviour using different quantitative techniques. This chapter aims to understand the constraints within which household travel decisions are made. Here the focus is on identifying the determinants of travel decisions within households using a qualitative approach. The qualitative approach is well-known for its ability to provide a deeper understanding of social phenomena. Thus, a qualitative method, a semi-structured interview, was utilised to obtain a better understanding of household behaviour (see chapter three, section 3.5.2, for more details).

The semi-structured interview was one of the primary data collection tools used to obtain the household head's view on how travel behaviour was structured, reasons for household travel decisions, and what constrained the household's travel alternatives. In this research, 33 interviews were conducted with selected household heads. All interviews were conducted by the researcher. Selection of 33 respondents for participation in semi-structured interviews out of a total sample of 380 households was based on several criteria, such as household structure (i.e. household size, age, and income group) and travel activity pattern(i.e. tour structure), (see Chapter Three for details).

The semi-structured interview was divided into three parts. The first part focused on understanding household travel patterns and sought to uncover the reasons behind household travel decisions. The second part presented the interviewee with suggested policies and elicited his views on these policies. The third part explored how proposed policies would affect the household's travel activities. Subsequent sections of this chapter will cover findings derived from the first part of the interview, while chapter 9 will cover those from the second and third parts.

Interviews with household heads took place in their homes. They were asked specific questions about their travel activity to and from work and what factors influenced household members' travel decisions. The researcher already knew the households' travel diaries from data provided in the collected questionnaires. The last question in the questionnaire had asked interviewees if they would be willing to participate in a further in-depth interview related to their travel behaviour activities. Over half of household heads (258 out of 380) were willing to do so (67%), reflecting their interest in the study, the research tool's suitability, the relevance of the questions, and the effectiveness of the research approach in general. The sample drawn for interview purposes was considered representative of the 380 households who had participated in the first questionnaire.

Section 8.2 presents background details on interviewees. Section 8.3 details factors influencing household travel behaviour. Section 8.4 presents obstacles to travel decisions. Finally, section 8.5 summarises the contents of this chapter.

8.2 Background details on interviewees

Chapter 6 presented the travel purposes of Saudi households. It is important to remember that, as explained in the research methodology, Chapter 3, the study covers all travel activities performed outside the home for all household members aged 6

years old and above, including all travel modes, trip lengths, and purposes. Travel to the mosque formed 23.6% of all household travel activities, and this reflects the cultural environment of Muslim communities, where all adult males are required to perform prayers five times during the day and night. According to Islamic regulation, a person receives 27 more blessings for praying in the congregation at the mosque than at home alone.

Another cultural factor is that, according to Islamic regulation, girls' schools are completely segregated from boys' schools. This factor has an influence on travel activities as children of different genders in the same family have to go to different schools, even if they study at the same level. This, of course, leads to an increase in the number of trips.

Adult males in the household play very important roles in household travel activities. First, they perform the travel activities related to their own needs, i.e. travel to work, shops, mosque, etc. Second, they serve other household members as passengers, and this may take two forms:

- Serving passengers on their way to or from their own destination, for example, dropping off a child at school on the way to work.
- Serving passengers on independent tours, i.e. taking children to school and returning home.

Table 8.1 shows adult males perform a substantial role in serving other household members. About 21% of adult males' tours were made to serve passenger needs, indicating adult males' commitment to serving other household members' travel needs. A household head, the father of two boys and two girls, commented:

> *"I am the driver for my family and I have to manage my time to cope with my children's travel activities, otherwise they will stay at home and forget about school."*

Another reported on his role as a chauffeur to serve his daughter's educational needs:

> *"In reality, I act as a chauffeur, I have to leave my job early to pick up my daughter from college and give her a lift home."*

Table 8. 1 Car tours performed by adult males

Tour purpose	Frequency	Percentage %
Serve own needs	1069	70
A tour including a stop to serve a passenger	141	9.3
A tour to serve a passenger	316	20.7
Total	1526	100

Source: Household Survey, 2003.

8.3 Factors influencing travel behaviour

Interviewees mentioned different factors affecting their travel behaviour. These factors can be classified into four categories: household characteristics, head's type of work, safety, and weather.

8.3.1 Household characteristics:

Almost all household heads indicated that household characteristics influenced travel behaviour. Interviews revealed that factors, such as household size, the number and gender of children attending school, and women in employment, affected travel behaviour. These factors are discussed in detail below.

8.3.1.1 Family structure

Interviews revealed the influence of the household structure on household travel behaviour. A head of a household with no children, or with children under school age, tended to commute on a simple tour: home-work-home. Three of the 33 household heads interviewed could be classified in this group, as families with no children or with children under school age. When asked why he did not stop on his way to or from work, one interviewee answered:

> *"We prefer to engage in our non-work activities in the afternoon or evening, such as visiting friends, when we have time to do such activities rather than link such activities to work trips due to traffic in peak hours and the weather factor. It is cooler in the late afternoon/evening."*

The second group were families with children attending school, and formed the majority of the sampled households. The presence of children attending school was a key reason for commute tour complexity (see Figures 8.1). Because of the absence of school buses to boys' schools, unreliable girls' school buses, and lack of public transport, people tended to escort their children to and from school. Ten out of 33 household heads stopped on their commute tour to give a lift to children to or from school, while others made school only tours (home-school-home). Why did household heads link the school trip to the commute tour? Interviewees highlighted four factors:

- no appropriate path for pedestrians, thus, making it unsafe for children to walk to school.
- lack of school transportation.
- school too far away to walk.
- children would be late if they walked on their own.

From the interviews, the researcher found the age and gender of children influenced travel decisions. Male students tended to perform more independent trips to school than female students. In the case of male students, they become more independent as they get older, whereas female students become more dependent on others as they get older. As already noted, this is due to a cultural environment where women are respected and served by adult male members. The girls' education authority provides school buses, but they are insufficient in number to meet all female students' travel needs. Nevertheless, female students do use them to get home from school.

Figure 8. 1 an example of a complex commute tour during which the household head stops at schools

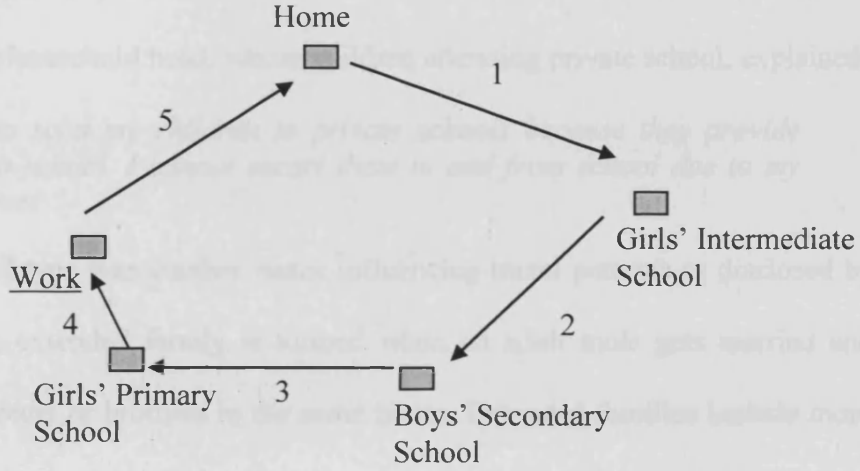


Figure 8.1a : an example of a complex commute tour to work during which the household head stops at schools

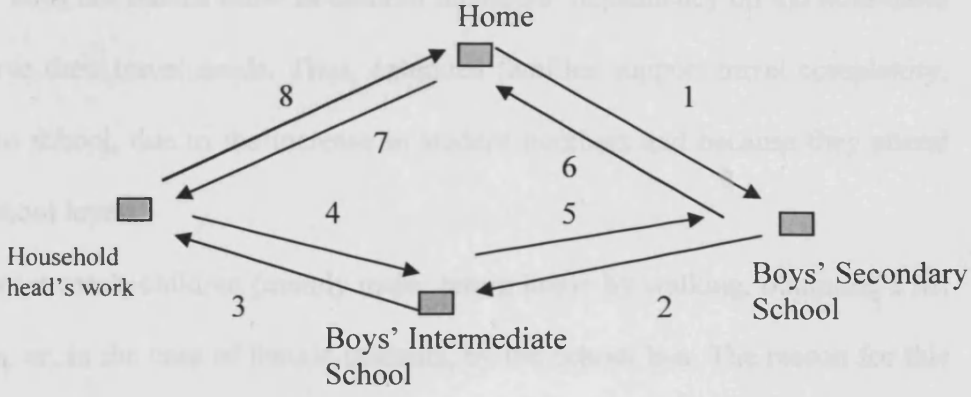


Figure 8.1b : an example of travel behaviour for a head who has to leave his work to give his children a lift from school to home and return to his work.

Interviews revealed that 3 households (8%) sent their children to private schools in order to benefit from the school transportation provided by these schools. This provision meant they did not have to hire a chauffeur to take their children to and from school. One household head, whose children attending private school, explained:

> *"I chose to send my children to private schools because they provide transport to school. I cannot escort them to and from school due to my working hours."*

Household type was another factor influencing travel patterns as disclosed by interviewees. An extended family is formed when an adult male gets married and lives with his parents or brothers in the same house. Extended families include more than one generation: adult children, children attending school, and children under school age. In this family group, the household head (the father) participates in most cases in a complex tour, escorting children to and from school, whereas adult male children commute to work in a simple tour. This suggests adult male children's availability does not reduce other household members' dependency on the household head to serve their travel needs. Thus, extended families support travel complexity, especially to school, due to the increase in student numbers and because they attend different school levels.

In most cases, children (mainly male) return home by walking, obtaining a lift from others, or, in the case of female students, by the school bus. The reason for this is the household head is engaged in his work. Also, many families justify their decision to recruit a chauffeur because they are not able to escort children to and from school.

8.3.1.2 Wife in employment

The second factor influencing complex travel behaviour in households is if the wife is in work. Many household heads were engaged in complex commutes to work

due to their responsibility to escort their wife to and from her workplace. The majority of female employees work in the educational sector and their working hours usually differ from those of their husbands who escort them to and from their workplace. Many household heads complained about the difficulty of solving this problem. They had four options.

The first option is to take a wife to and from her workplace; this means the household head has to ask for permission to take a break from his work to escort his wife from work to home. This option depends on the flexibility of the household head's working hours. The option has many drawbacks, for example, the productivity at work of the household head will decrease due to his absence while he is escorting his wife. His working relationships with colleagues may also be negatively affected if he asks for daily permission to leave his workplace, since they will have to take on his work duties in his absence. More trips are generated as the household head has to travel from work to his wife's workplace, then take her home, and return from home to the workplace (see figures 8.2). The second option used by the household head to transport his wife to work is to recruit a chauffeur who is employed to take his wife to work in one tour. This option, however, has cultural and social drawbacks as it increases household expenditure. Also, some families, due to Islamic regulation, do not allow women to travel alone with a chauffeur without being accompanied, so children have to accompany the wife, or families may recruit a housemaid to accompany the wife as a solution.

Figure 8. 2 an example of a commute tour of a household head with a wife in work

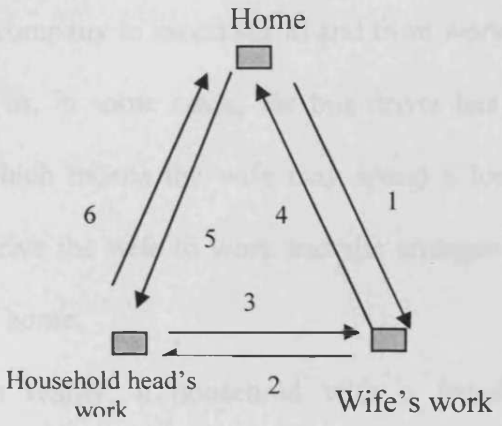


Figure 8.2a: an example of a commute tour of a household head who gives a lift to his wife to and from her work.

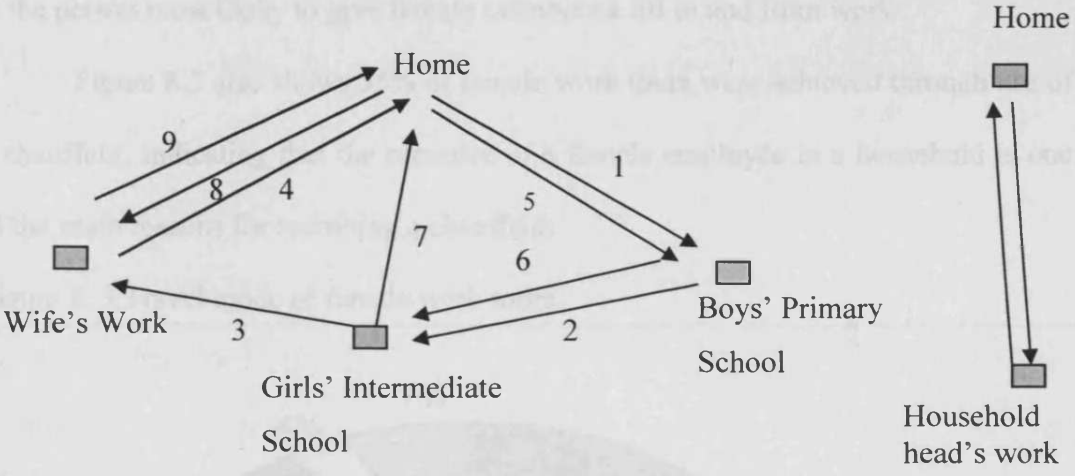


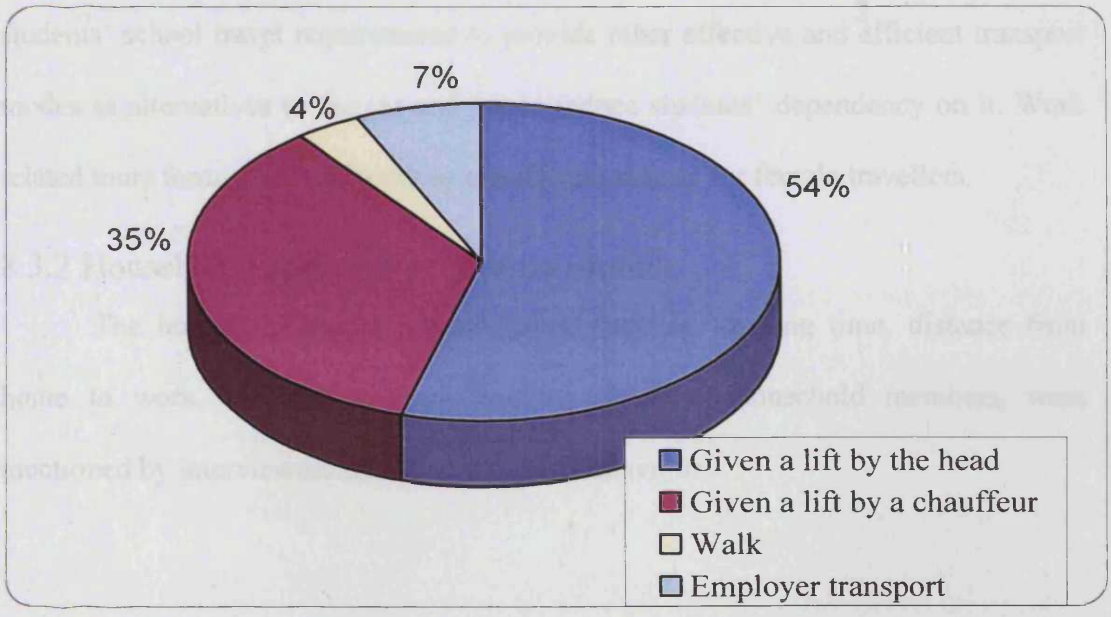
Figure 8.2b: examples of a simple commute tour for the household head, and complex tours by a chauffeur escorting children and wife to school and work.

The third option available for a wife in employment is to have a contract with a private bus company to escort her to and from work. This option costs money and is inconvenient, as, in some cases, the bus driver has a contract with up to 8 female employees, which means the wife may spend a long time on the tour. The fourth option is to drive the wife to work and she arranges with a friend or relative to give her a lift back home.

So, in reality, a household with a female in employment faces many difficulties. Households with females in employment comprised 20% of sampled households (76 out of 380 households). Figure 8.3 shows the travel mode used by females to travel to and from work. As expected, female members are greatly dependent on adult males to perform their work-related travel, and the household head is the person most likely to give female members a lift to and from work.

Figure 8.3 also shows 35% of female work tours were achieved through use of a chauffeur, indicating that the presence of a female employee in a household is one of the main reasons for recruiting a chauffeur.

Figure 8. 3 Travel mode of female work tours



Source: Household survey, 2003.

8.3.1.3 Availability of a chauffeur

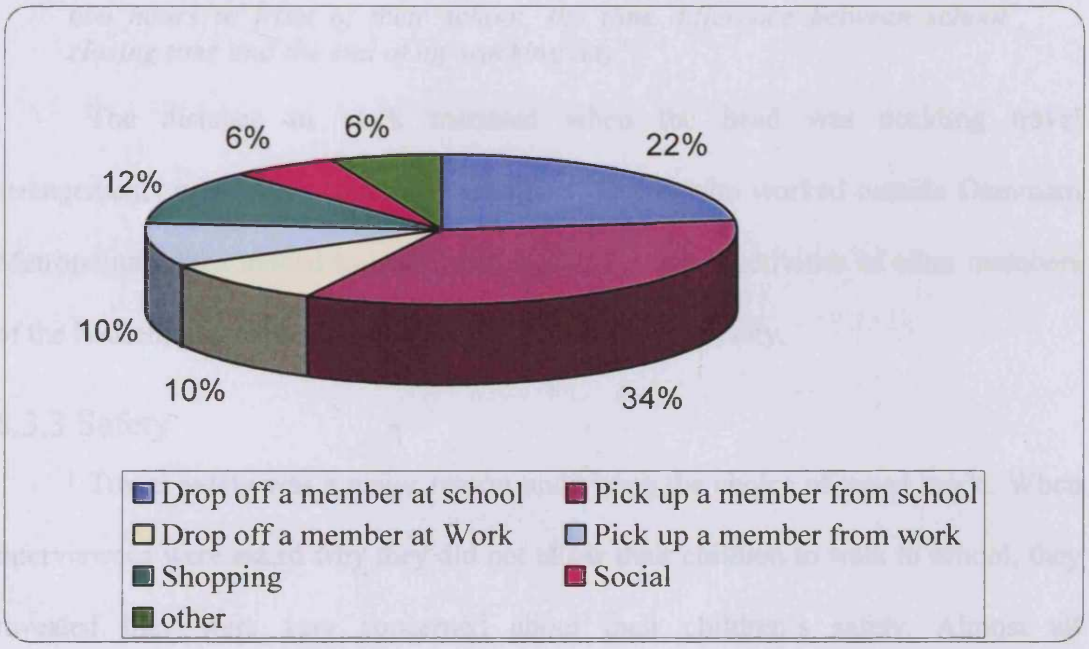
Interviewees mentioned different reasons for recruiting a chauffeur. These included a household head who cannot perform all the household travel activities, children attending school, a working wife, an elderly household head who is unable to drive, and, in some cases, families employ a chauffeur for social prestige. Of course, there are many, harmful effects upon the environment, though not necessarily to family members, involved in recruiting a chauffeur. These include the fact that family members feel free to look for a specific destination to go to, regardless of distance or travel time. In addition, more trips are generated as the chauffeur has to take household members from home to work, then return home, wait until household members' working hours are finished, then drive to their workplace to pick them up and then return them home. Another disadvantage of the availability of a chauffeur is that household members become more dependent on the car, and exclude other travel mode options, such as public transport and walking.

Figure 8.4 shows the travel activities performed by the chauffeur. About 56% of chauffeur tours are linked to school trips. This indicates the need to investigate students' school travel requirements to provide other effective and efficient transport modes as alternatives to the car and hence reduce students' dependency on it. Work related tours formed 20% of tours by chauffeurs, mainly for female travellers.

8.3.2 Household head's job-related constraints

The household head's job attributes, such as working time, distance from home to work, and the different working hours of household members, were mentioned by interviewees as affecting travel behaviour.

Figure 8. 4 Travel purposes of household Chauffeurs



Source: Household survey, 2003.

Interviewees indicated that their working hours did not allow them to easily participate in the travel activities of other members of the household. For instance, if a household head has to leave home at 6:00 am, he will not be able to take his children to a school which starts at 7:00 am. Similarly, if he arrives home late at 5:30pm he will not be able to serve household members' needs in the late afternoon. Besides long working hours, household heads complained about school hours which open at 7:00 am and close between 12:00 and 13:40, depending on the school level. School closing times differ from employees' working hours. This situation leads to two options. Some households may decide to look for another travel mode rather than rely on the household head to escort household members, i.e. walking, school bus, private bus, recruiting a chauffeur, or a lift given by a relative or friend. The other option is to leave work, pick up children, escort them home, and then return to work. When one interviewee was asked whether leaving work during working hours decreased his productivity, he replied:

"Yes, of course it does, but what can I do? I cannot let my children wait two hours in front of their school, the time difference between school closing time and the end of my working day"

The distance to work mattered when the head was deciding travel arrangements with other household members. Heads who worked outside Dammam Metropolitan Area tended to participate less in the travel activities of other members of the household than heads who worked inside Dammam city.

8.3.3 Safety

Travel safety was a major reason underlying the choice of travel mode. When interviewees were asked why they did not allow their children to walk to school, they revealed they were very concerned about their children's safety. Almost all interviewees criticised the safety aspects of their neighbourhoods, stating they were not safe for pedestrians. According to interviewee heads, three reasons restricted household members walking: inappropriate walking environment, driver behaviour, and child security.

I- Inappropriate walking environment:

The urban environment is not designed for pedestrians as there are no pedestrian paths leading to services; pedestrians have to cross roads. For example, in Aljamayen neighbourhood, paths planned for pedestrians have been converted for use as roads without the local authority objecting to this changed usage. There is an absence of signs warning drivers about the presence of pedestrians, zebra crossing areas, and pedestrian traffic lights. The presence of latter would enable pedestrians to cross roads in safety. Moreover, there is no assistance given to young children when they try to cross roads in peak hours. All these factors make the decision to walk a risk, especially for young children.

II- Drivers' behaviour:

Many heads disclosed their concern about unsafe driving in the streets, especially during peak hours when children go to school. The high speed of young drivers makes household heads very anxious about allowing children to walk alone to school. Many told the interviewer that an adult member had to accompany young children to school. Other household heads had decided to drive children to school in the morning in the peak period and allow them to return on foot when streets are less congested at noon.

One household head who lived in front of a girl's primary school told the interviewer that he had to help his 6 year old daughter cross the road:

> *"I am very worried that speeding drivers are allowed to drive as recklessly as they do, especially the drivers of private buses who drive at high speed, which puts the life of passengers (young students) and pedestrians at great risk."*

III- Children security:

Interviewees expressed concern about their children's security when they travel on their own to school. Household heads did not allow very young children of either gender to walk to school alone. Male students above a certain age are allowed to walk to school on their own, even if the school is quite a distance from home. However, female children are not allowed to walk on foot to school as they get older. Families are afraid of strangers harassing them. Thus, travel decisions related to children are influenced by both security and safety concerns which, in turn, increase children's dependency on the household head to serve their travel needs and generate more car trips.

8.3.4 Weather

Interviewees indicated that the weather in Dammam does not encourage walking. In summer time, high temperatures and high humidity make it

uncomfortable for household members to walk long distances, especially in the day time. At night, the weather is cooler and more moderate, making it possible for people to walk, mainly to the mosque and for exercise.

8.4 Constraints affecting household travel decision

Saudi households face constraints when travel decisions are taken. These constraints are related to the transportation system in Saudi cities, as well as the natural, cultural and urban environments. The majority of interviewees highlighted the following issues.

8.4.1 Lack of school transport

School trips formed about 24% of total tours, without counting stops within tours for other purposes. Many household heads expressed their dissatisfaction with school transport. For boys' schools there is no school transport at all. The girls' schools authority provides school buses but these do not cover all schools, and do not offer sufficient seats to accommodate all students in schools covered by the bus service. The service therefore is inconvenient. All participants agreed on the importance of school transport. As noted above, to overcome the lack of transport, adult males take children to school, recruit a chauffeur, contract with a privately-owned minibus, or pupils of both genders have to walk on unsafe roads.

8.4.2 Unreliable, inadequate bus service

As discussed in chapter 4, a public bus company "SAPTCO" has an exclusive monopoly for running public buses in Saudi Arabia. For financial and operational reasons, SAPTCO is running down its provision of intra-city services, which has led to a decrease in the number of routes run in Dammam. Fewer areas are served by SAPTCO bus services, resulting in a decrease in the number of passengers using SAPTCO services (see chapter four, section 4.10.1). Interviewees indicated that the

provision of a public bus service would give them the option to use it for work, or children could use it to reach schools.

8.4.3 Ignorance of female travel needs

Both the public and private sector employers, who recruit female employees, ignore the transport needs of this group. As has been explained, women are not allowed to drive a car in Saudi Arabia, so they need a transport mode to travel to their workplaces. The existing situation is that females depend on adult males, or on a chauffeur, or look for a relative to give them a lift to/from their workplace.

8.4.4 Car-oriented built environment

Neighbourhoods are designed for car users rather than walkers. In Dammam's neighbourhoods, the car takes priority over pedestrians and other travel modes. Interviewed household heads reported that the local environment was not pedestrian-oriented. Pedestrian crossing areas and pedestrian traffic lights are absent. Looking at the areas surrounding schools, most have no crossing areas for pedestrians, no traffic signs cautioning drivers that children are in the vicinity, and no adult person to help children cross the road safely. These factors discourage household members from walking to their destinations.

8.4.5 Service provision pattern

Many interviewees complained about the lack of schools in their neighbourhoods. For instance, Petromin, a newly developed neighbourhood, is facing a shortage of facilities, such as secondary school for both genders. Consequently, residents have to take their children of secondary school age to the nearest secondary schools which are located far away from Petromin. The nearest secondary school for girls is 7.4 km away, which increases car dependency. As services become more distant, so cars are in greater demand.

8.5 Summary

This chapter has introduced the results of the qualitative analysis method used to obtain a deeper understanding of household travel constraints in relation to travel activities. From interviewing 33 household heads, the chapter has presented reasons for travel and identified factors influencing the travel behaviour of Saudi households. The family structure clearly affects travel behaviour. Factors such as household size and children attending school are influential in household travel decisions. Females in employment also significantly affect the travel attributes of the household.

The interviewed household heads revealed their jobs influenced their travel decision to give a lift to a household member, as well as distance to work, working hours and flexibility of working hours. These factors played an important role in the household head's travel behaviour.

Safety was another crucial factor affecting household travel behaviour. Many participants expressed concern about their children's safety, a concern which forced them to drive their children to school, even though the school might be within walking distance.

From the interviewees' point of view, factors such as lack of school transport, absence of public transport, ignorance of female travel needs, and a neighbourhood design which is more car-oriented than pedestrian-oriented, influenced household travel behaviour by enforcing their travel decision to rely on car use.

The next chapter will introduce findings derived from the second part of the semi-structured interviews conducted with household heads. Chapter 9 will also present proposed policies and household heads' responses to these policies.

CHAPTER NINE

Responses to Proposed Policies

9.1 Introduction

This chapter aims to examine study participants' responses to hypothetical transportation and land use-related policies and how such policies are likely to change their households' travel behaviour. The previous chapter, chapter 8, discussed obstacles facing Saudi households' travel behaviour. Here five policies are proposed to overcome these constraints. Section 9.2 introduces the proposed policies, while section 9.3 details interviewees' responses to them. Changes in household travel behaviour in reaction to the proposed policies will be presented in section 9.4. Section 9.5 concludes the chapter and presents a general consideration of proposed policies and their likely effects on households' travel behaviour.

9.2 The proposed policies

The study presents five policies, which are aimed at reducing car dependency within households and associated travel complexity. All these proposed policies seek to allow individuals more travel choice options. These policies can be classified into two categories as:

1. Spatial policies: two of the five policies are connected to the spatial distribution of, and accessibility to, services: introducing service centres within walking distance from home and introducing safe pedestrian paths to existing services.

2. Transportation supply policies which are concerned with providing transportation alternatives to groups with particular needs: children attending school and females. Provision of an accessible, reliable and cheap female-only public transport service aims to allow females to travel independently from adult males. This policy tries to provide public transport which respects female privacy. The fourth policy targets children attending school. The inadequate girls' schools' bus services and the absence of boys' schools' buses were found to influence the structure of household tours. This policy aims to improve children's accessibility to school, allowing them to travel to and from school independently. The fifth policy focuses on the needs of female employees. This policy is designed to encourage employers of females to provide transport for their employees.

The proposed policies were presented to a sample of 33 household heads. The next section provides a descriptive account of the sampled interviewees' responses to them.

9.3 Household heads' responses to the proposed policies:

This section details household heads' responses to the proposed policies that were introduced and explained to them. They were asked if the policies would cut down the number of car trips and asked to indicate, using a Likert measurement scale, whether they strongly agreed, agreed, did not know, disagreed or strongly disagreed with each policy. If interviewees were in favour of a policy they were asked to name its advantages. If they disagreed with a policy, they were asked to explain its disadvantages and suggest ways in which it could be improved to become acceptable to them. In the following, the study details whether interviewees were in favour or opposed to each proposed policy and why.

9.3.1 Introduce service centres within walking distance of home:

This policy aims to provide service centres, including facilities needed by neighbourhood residents, such as primary schools for both genders, shops, and a mosque, within walking distance of homes. Hence, users are encouraged to walk rather than use cars. Many interviewees experienced difficulty due to services being far from home, especially schools.

Participants were asked if this policy would indeed lead to a cut in the number of car trips. All interviewees agreed that this policy would decrease car dependency within the household. Eighty-two per cent strongly agreed with the policy, which indicated support for it and their willingness to shift from using a car to walking if the spatial distribution of services considered the distance to users an important factor.

When interviewees were asked why they supported this policy, in other words, what was the advantage of this policy, they focused on three themes:

1- Reduced car dependency: All participants agreed that providing a service centre within walking distance would decrease car dependency. About 50% of interviewees suggested this policy would lead to fewer car trips. Three interviewees indicated this policy would reduce their travel time as services would become nearer to users. Five participants pointed out that a reduction in car trips would mean decreased car usage running cost (i.e. fuel cost).

2- Improved accessibility to services: Interviewees indicated that a policy of providing service centres would be supported because it would improve accessibility to facilities needed by residents. Thirteen interviewees (39.3%) claimed this policy would improve the accessibility of facilities'. Three heads agreed this policy would improve children's accessibility to schools (because they could travel alone) which would lead to decreased dependency of household members on the household head.

3- Encourage people to walk – leading to a more healthy environment: The majority of heads interviewed were confident this policy would reduce the number of car trips and shift people's attitude towards walking. Ten interviewees supported this policy, indicating it would encourage people to walk, which would lead to health benefits. Any shift away from car use to walking would have a positive influence on public health, since car congestion and harmful exhaust emissions would be reduced. A household head, who had not mentioned any walk trips in his travel diary, commented:

> *"Improving the pedestrian environment would encourage me and many others to walk to the mosque, shop, and walk for exercise."*

9.3.2 Introduce a safe pedestrian path to existing services

The second policy aims to encourage residents to walk by providing a safe pedestrian path to services. This would involve the provision of pedestrian paths suitable for use by all community members, including children, women, and the elderly. Users of pedestrian paths will be protected from car intervention through the provision of appropriate zebra crossings, pedestrian traffic lights, and traffic signs where appropriate. Ninety-two per cent of interviewees were in favour of this policy because of its safety and security aspects. All participants agreed this policy would improve pedestrian safety by decreasing the interaction between cars and pedestrians. They expressed their concern about their children's safety when they have to travel between home and school. Additionally, interviewees revealed their strong concern about children's security when they travel alone, particularly female children and young children of both genders. Participants pointed to other factors favouring this policy, namely: decreased travel time and encouraging people to walk to practise a healthy habit. Interviewed household heads also emphasised certain requirements for

the proposed pedestrian paths: they would need to be sufficiently wide, have good furniture, be well- lit, and well- maintained.

However, one interviewee disagreed with this policy because he thought children would not follow the pedestrian path, but use short cuts which might involve crossing roads and exposing themselves to a dangerous situation. He was also against sending his young daughter to primary school alone without an escort, although the school was very near his home. He said:

> *"I am not going to let my daughter, 6 years old, cross the road alone, due to the way drivers drive, especially young drivers."*

9.3.3 Provision of accessible, reliable and cheap "female-only" public buses

This policy was less popular with household heads. Just over half (57%) supported this policy, while 30% opposed it, and 12% were uncertain about it. Thus, this policy generated the highest opposition among those proposed. Interviewees in favour of this policy named three advantages:

i) This policy would lead to a reduction in the number of car trips made by household heads. Interviewees were confident that by providing an appropriate and reliable female public transport service, this would lead to a cut in the number of car trips performed by household heads to serve female members' travel needs, especially those of females in employment. Also, the option would save households' time and costs incurred escorting female members to their destinations.

ii) The policy would end the need for a chauffeur. Interviewees agreed it would give females the opportunity to travel independently. In the current situation, chauffeurs are employed to serve female members' travel needs when male household members are unable to do so.

iii) This policy would give females greater freedom to travel to their destination depending on the frequency and times of bus services and the destination served. Female members currently depend on adult males to serve their travel needs. Hence, providing such facilities for females would enable them to travel to school and work, independently.

Although this policy was considered to have advantages, many interviewees opposed it, mainly because they were concerned about females' privacy and breaking Islamic regulations. Those against this policy mentioned two points of concern:

a- This option would erode a female's privacy when she rides on a public bus and while she waits for a bus. A household head whose wife worked commented:

> *"I am not convinced that women are able to wait for a bus in the street, spend a quarter of an hour alone at the bus stop"*

b- The policy is against tradition: women are traditionally always looked after by adult males, so if people see females approaching a public bus they will view this as strange behaviour. Some were also against this policy because it would allow women to travel alone and this would conflict with tradition rather than Islamic regulation, since it is usual for women to be accompanied when they travel outside cities.

It is important to mention that Saudi households are not accustomed to use public transport. Although public transport has been in existence in Saudi cities since the late 1970s, the majority of public transport users are non-Saudis. All the aforementioned factors may explain the opposition to this policy.

9.3.4 Provision of safe and cheap school buses:

This policy is aimed at students. The trip purpose analysis revealed 24% of tours were to schools. The study therefore sought a policy to reduce car dependency for school tours. By providing a reliable, safe, and cheap school bus, the research hypothesises that students will be less dependent on household heads to escort them to

and from school. The majority of interviewees were in favour of this policy: 97% supported the policy; only one participant disagreed with it (a father on a low income with four children attending school who thought he would not offer to pay for school buses for his children), the high support for this policy reveals the extent to which students need school buses, and are willing to switch to this alternative. Participants highlighted four themes:

a) This policy would reduce traffic congestion, especially during peak hours. Thirty-three per cent of interviewees agreed that providing a school bus would lead to a reduction in car use for escorting children to school, so traffic congestion would be reduced. Providing reliable school bus services would mean that up to 24% of school tours made by car (from travel diaries of 380 households) might shift to school buses.

b) The policy would prevent workers from arriving late at their workplace after giving a lift to school, or leaving work during working hours. Providing school buses this would give adult males more freedom in their commuting travel. They would not need to make one or more stops on their way to and from the workplace.

c) Providing a school bus would lead to a reduction in the number of car trips made by adult household members in order to give lifts to children on their way to other destinations (e.g. complex work tours, home-school-work-home). This cut in the number of car trips as mentioned by interviewees would have an economic impact, since car costs would also be reduced. It would also save the time of members currently escorting children to school.

d) School bus provision would improve the safety of children. According to 25% of heads, school buses would improve children's safety on school tours. Cuts in car trips, because of a bus to school, would decrease the traffic around schools which would possibly decrease accident numbers.

9.3.5 Provision of work-based transport for female employees:

This policy targets females in employment, aiming to improve their commute tour, providing them with the option of travelling independently in a private bus to their workplace. Interviewees were in favour of this policy: 74% strongly agreed and 24% agreed with it. Interviewees highlighted two advantages:

First, household heads would make fewer tour trips and enjoy greater flexibility: in the existing situation, the household head is involved in female employees' travel to work; he has to give them a lift to and from work. Providing transport for female employees would relieve the household head of this duty. His participation in female employees' travel entails several drawbacks. He arrives at work late and needs to ask for permission to leave within working hours to pick up his wife or daughter(s) at their workplace and take them home. So the household head would benefit from the implementation of this policy.

Second, females in employment would become more independent: all participants agreed that female employees would become more independent in travelling to work. In the existing situation, female employees depend highly on adult male members to give them a lift to and from work. Because they depend on others' timetables, sometimes female employees have to wait for hours before being picked up from work and driven back home.

In conclusion, table 9.1 shows the responses of household heads to all the proposed policies which aim to increase the independence of travellers presently dependent on adult male members to serve their travel needs. Interviewees were strongly in favour of four policies. Introducing service centres within walk distance from home was the most popular option. However, interviewees were doubtful about introducing public transport for females only for cultural and security reasons.

Table 9. 1 Interviewees' response to proposed policies

Policies/response	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Introduce service centres	81.8 %	18.2 %	0	0	0
Introduce safe pedestrian path	69.7 %	21.2 %	6.1 %	3 %	0
Provision of female only public transport	45.5 %	12.1 %	12.1 %	18.2 %	12.1 %
Provision of school bus	75.8 %	21.2 %	0	3 %	0
Provision of work-based transport for female employees	69.7 %	24.2 %	3 %	3 %	0

Household Interview, 2003.

9.4 Implications of the proposed policies

The aim of all the proposed policies is to cut the number of car trips by decreasing dependency on household adult males. Interviewees were asked "how would your travel activities be influenced by the proposed policies?" The study applied the stated intention technique, which is popular in the transportation literature for its ability to reveal changes in users' travel behaviour as a result of proposed policies. All interviewees indicated their travel activities would change if the proposed policies were implemented.

Current household travel patterns are influenced by the number of children attending school. The trip generation model developed in chapter 6 shows the number of children in school significantly influences the number of car trips generated by a household. School is a popular destination. In the study, 867 car trips made to/from schools contributed to 24% of total car trips made by the 380 households participating in the study. Table 9.2 shows students travelled to/from schools mainly as car passengers. Only a few students used school buses, due to lack of adequate provision of such services.

Table 9. 2 School tour travel modes

Travel mode	Frequency	%
As a car passenger	282	60%
As a car driver	101	21%
School bus*	85	18%
Other	3	1%
Total	471	100%

Source: Survey of 380 households. * includes private mini bus.

In addition to school tours, where school is the main purpose of travel, children were given a lift to school by household members on their way to other destinations. School stops were linked most to work tours: 21% of school stops occurred in work tours. Children were given lifts to school by adult male students on their way to school/college. Twelve per cent of school stops occurred in tours serving the needs of children attending other schools.

Figure 9.1 shows the existing typology of complex tours involving school stops. It can be seen that school stops are associated with complex work tours due to the dependency of students on household heads for their travel activities.

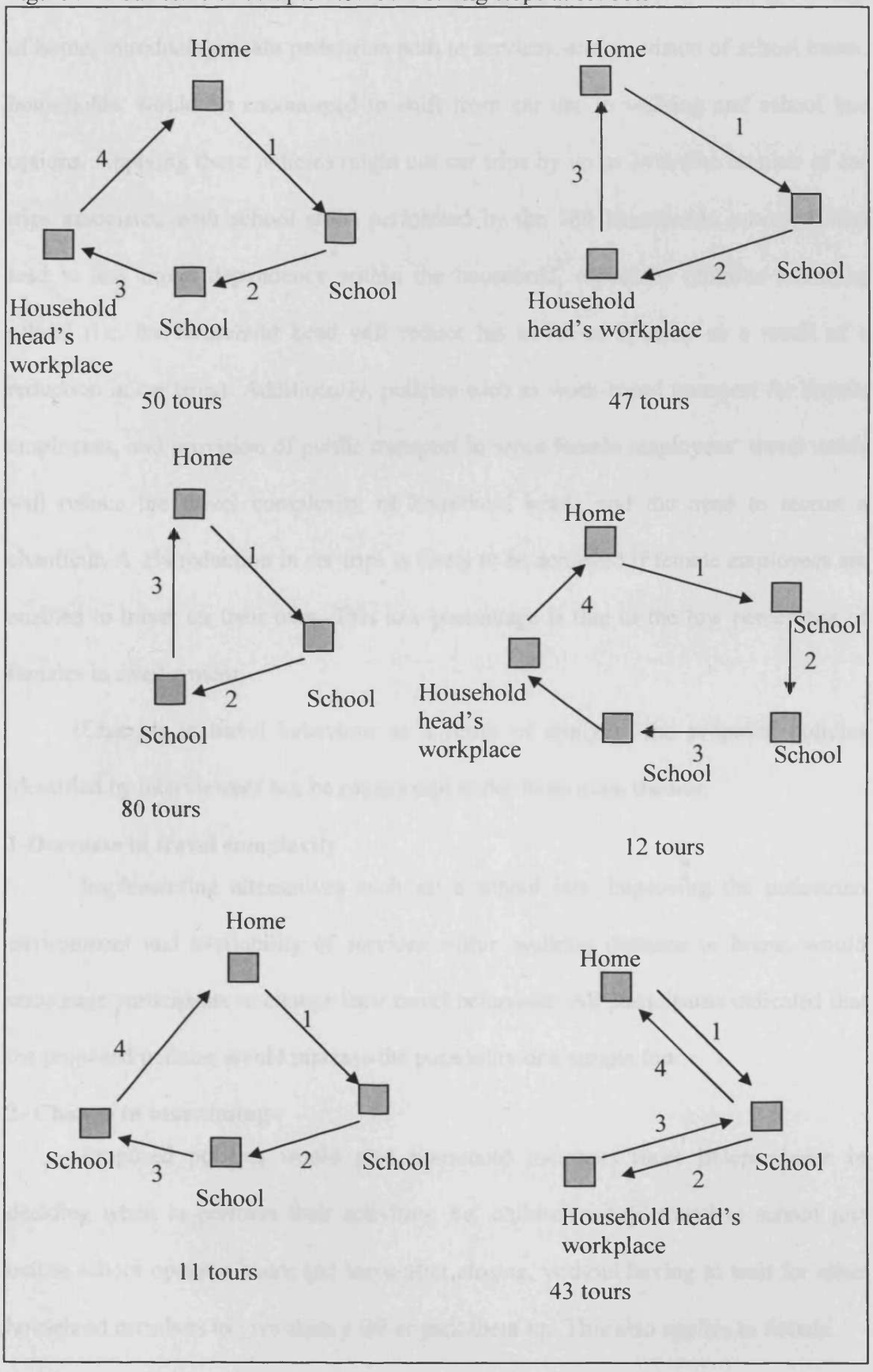
Female employees are another group of travellers who depend greatly on adult males. Fifty tours were produced in order to serve female employees. Table 9.3 shows the structure of tours, including stops, to serve female employees.

Table 9. 3 Structure of tours serving female employees

Driver	Tour structure	Frequency
Household head	Home- wife's work- Home	6
	Home- wife's work- Work- Home	9
	Home- Work -wife's work- Home	2
	Home- wife's work- Work -wife's work- Home	5
Chauffeur	Home- wife's work- Home	16
	Home- school- wife's work- Home	12
	Total	50

Source: Survey of 380 households.

Figure 9. 1 Structure of complex tours involving stops at schools



Through policies, such as introducing service centres within walking distance of home, introducing a safe pedestrian path to services, and provision of school buses, households, would be encouraged to shift from car use to walking and school bus options. Applying these policies might cut car trips by up to 24% (the number of car trips associated with school stops performed by the 380 households surveyed) and lead to less travel dependency within the household, especially children attending school (i.e. the household head will reduce his travel complexity as a result of a reduction in car trips). Additionally, policies such as work-based transport for female employees, and provision of public transport to serve female employees' travel needs will reduce the travel complexity of household heads and the need to recruit a chauffeur. A 2% reduction in car trips is likely to be achieved if female employees are enabled to travel on their own. This low percentage is due to the low percentage of females in employment.

Changes in travel behaviour as a result of applying the proposed policies identified by interviewees can be categorised under three main themes:

1-Decrease in travel complexity

Implementing alternatives such as: a school bus, improving the pedestrian environment and availability of services within walking distance to home, would encourage participants to change their travel behaviour. All participants indicated that the proposed policies would increase the possibility of a simple tour.

2- Change in tour timing

Proposed policies would give household members more independence in deciding when to perform their activities. So, children would travel to school just before school opening hours and leave after closing, without having to wait for other household members to give them a lift or pick them up. This also applies to female

employees. In addition, the household head would not need to leave home so early in the morning to give children a lift to school.

3- Relieve traffic congestion produced by multi-stop tours

Tours would become simpler because secondary stops to give a lift to other household members would decrease. Work tours involving stops at schools would no longer be necessary as children would walk or use the school bus in a safe environment. Further, tours performed during working hours to give lifts to household members would no longer be necessary since all household members would use alternative travel modes to serve their travel needs.

Most participants who had a chauffeur welcomed the proposed policies. There would be no need to hire a chauffeur, which would save them money. Households with contracts with private buses would be able to cancel them, which would also save them money. Additionally, the household heads interviewed commented that reducing the number of trips to schools would reduce their expenditure on car fuel. All the above were viewed as welcome changes in household travel behaviour. It is also important to mention the advantage of bus services for households with children, but to keep in mind the fact that school bus services are expensive for the local authority to run. Before introducing such services, cost-benefit analysis should be undertaken to weigh up the advantages and disadvantages to the community.

One household head, with children in school, showed support for the policies and agreed his household's travel activities would change if two particular policies were implemented, namely, providing service centres within walking distance of his home and/or providing school buses. Their implementation would mean school tours could be performed by children themselves without adult males' involvement, as was currently the case. Figure 9.2 compares household activities before and after the proposed policies. Figure 9.2(a) shows how the adult son is involved in complex

tours. Children attending school depend highly on their brothers who give them lifts to and from school. Figure 9.2(b) shows how the adult son performs his tour without complexity.

Another household head, with a wife in employment, was in favour of the policy to introduce work-based transport for female employees, to escort them to and from home. He was confident this policy would encourage more females to enter the labour market and relieve the household head of his responsibility to escort females to and from work. Figure 9.3, shows how the household head would benefit from the introduction of female employees' transport, as well as society in general. The household head's work productivity would increase, as he would not have to leave his employment during work hours to give lifts to household members.

In summary, if the proposed policies were to be applied, car trips would be cut by up to 26% (this figure is based on the total number of travel trips performed by the 380 households surveyed). Interviewees were also in favour of the proposed policies aiming to cut the number of car trips performed to serve the travel needs of children at school and females in employment. Further, the current average number of 9 car trips per household per day would be cut to 7 car trips, implying each household would save the cost of two car trips each day.

Figure 9. 2 A comparison between school tours before and after proposed policies (School transport)

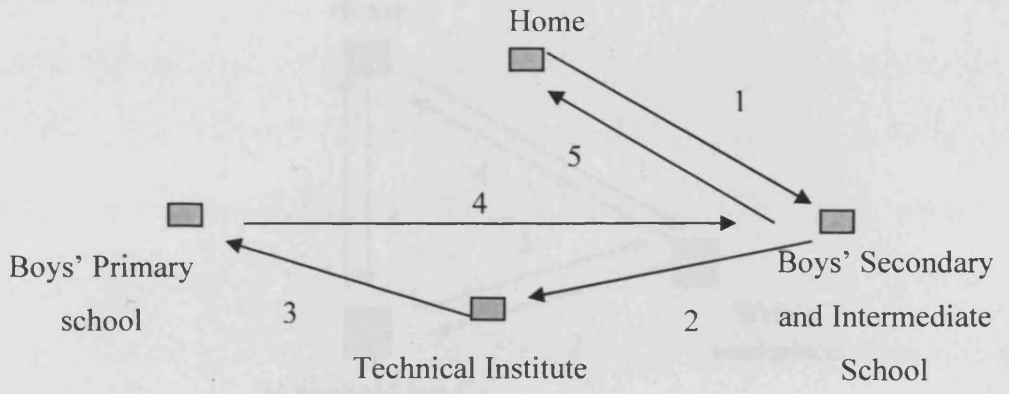


Figure 9.2 (a): an example of a complex car tour by an adult male involved in escorting his brothers to and from schools.

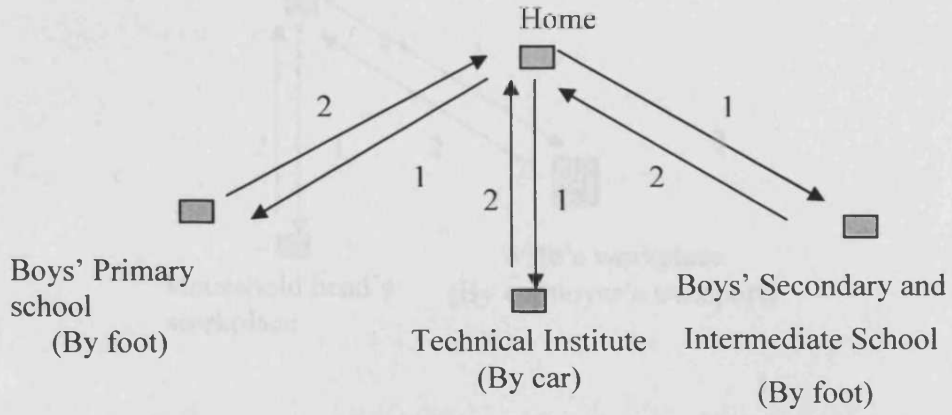


Figure 9.2 (b): Changes to travel behaviour as reported by a household head. Children attending school would be able to travel alone to school.

Figure 9. 3 A comparison of household travel activities before and after proposed policies (Work-based transport_)

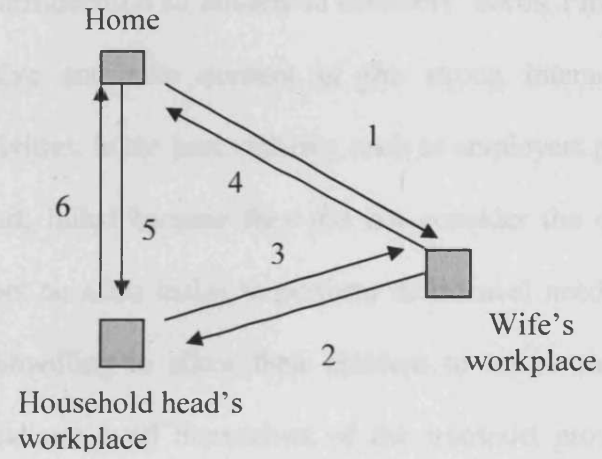


Figure 9.3 (a): example of a complex car tour by a household head involved in escorting his wife to and from her work.

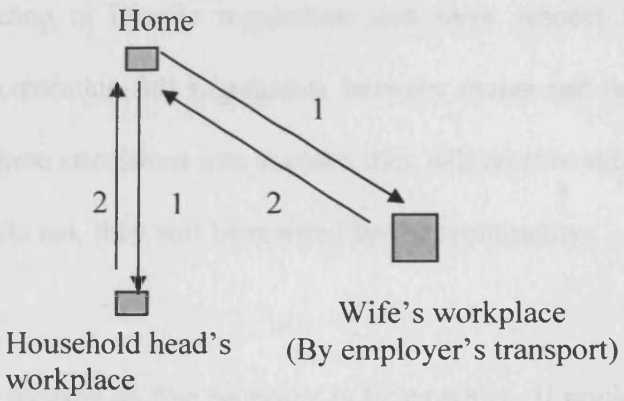


Figure 9.3 (b): Changes to travel behaviour as reported by a household head. Wife would use transport provided by employer to and from work.

9.5 Important considerations for transportation-related policies

Saudi household travel behaviour is complex and highly dependent on adult males in the household. Therefore, any proposed policies focusing on household travel should take into consideration all household members' needs. Proposed policies should be comprehensive and take account of the strong interaction between members' needs and activities. In the past, policies, such as employers providing male employees with transport, failed because they did not consider the dependency of other household members on adult males to perform their travel needs. In addition, male employees were unwilling to allow their children to travel on their own to school, and therefore did not avail themselves of the transport provided by their employers.

Another important factor, of which transport planners should be fully aware, is the significance of women's privacy in Saudi communities. All proposed policies should be tested according to Islamic regulations and show respect for women's privacy and the need to maintain full segregation between males and females. If the proposed policies take these conditions into account they will receive support for their implementation. If they do not, they will be resisted by the community.

9.6 Summary

This chapter has focused on five proposed policies which, if implemented, it is believed, will influence household travel decisions. The first part of this chapter presented the results of semi-structured interviews conducted to establish to what extent interviewees would be willing to accept the proposed policies. The second part used the stated intention technique to evaluate changes in travel behaviour as a result of introducing the proposed policies. Interviewees strongly supported four of the proposed policies, suggesting the urgent need to introduce them to overcome the

obstacles facing Saudi households' travel behaviour. However, interviewees were doubtful about one policy, that of providing "female only" public transport, because of the cultural environment where women's privacy is very important and Saudis generally do not use public transport.

The interviewed household heads thought the most important advantage of implementing the proposed policies would be the reduction in household members' dependency on the car which, in turn, would reduce travel complexity, since escort tours would decrease significantly in number. Household members unable to drive, children and females, would benefit as the proposed public transport modes would encourage them to travel independently. Interviewed household heads also indicated that travel costs would significantly drop due to the reduction in the number of car trips. Many household heads suggested some households would no longer need a chauffeur.

This chapter has discussed to what extent the proposed policies would influence travel behaviour. Semi-structured interviews with household heads elicited likely changes in travel behaviour. These included decreased travel complexity, simpler tours, changes in tour timing, and reduced traffic congestion. The study estimated a reduction in car trips generated by households of up to 26% as a result of introducing policies aimed to shift dependent groups (i.e. children and females) towards independence through walking and use of public transport.

The study highlighted two major factors transport planners should consider when proposing a new strategy or policies related to travel behaviour. First, households are highly dependent on adult males to perform their travel activities and, secondly, the high priority given to women's privacy in the Saudi context.

Chapter 10 will provide an overview of the study's main findings, introduce recommendations for future research, and highlight the research's contributions to the literature and travel behaviour field.

CHAPTER TEN

Conclusion

10.1 Introduction

The aim of this research has been to study the determinants of travel behaviour in an Islamic environment. Saudi Arabia was selected as a case study to examine the influence of the cultural environment, socio-economic characteristics, and urban development characteristics, on travel behaviour.

The theoretical framework underlying this research has been the activity-based approach, which views household travel decisions as the interaction between household members' characteristics and their activity needs, influenced by cultural and land use factors to form the tour structure pattern. The study utilised the tour-based model to capture the interaction between activities and household members' needs (Bradley et al., 1999). The trip-based model was also employed to determine factors influencing the trip rate of households.

Data required to analyse travel behaviour characteristics were collected in Dammam, the city selected for the research investigation. Three hundred and eighty households were interviewed to obtain their travel diaries and household characteristics. In total, 2746 tours were coded and computed, including household socio-economic and tour characteristics. Semi-structured interviews were also conducted with 33 household heads to investigate in-depth factors influencing household travel decisions. Interviewees were presented with five proposed policies,

asked to evaluate them, indicate their likely responses to them, and identify how they might impact on their travel behaviour.

The findings related to the two objectives addressed in this research are highlighted in section 10.2. The research's contribution is discussed in section 10.3. Research limitations are subsequently detailed in section 10.4.

10.2 Addressing the research objectives

This section highlights the research methods implemented and developed to address the research objectives. It also summarises the main findings derived from each objective.

10.2.1 The first objective: To identify the main characteristics of the travel behaviour of Saudi households

The first objective was achieved by exploring the nature of household travel behaviour, explaining the variation in households' travel behaviour, and establishing its determinants. This objective was accomplished using various research methodologies. The travel diaries of sampled households were descriptively analysed. Chapter five described the travel behaviour of households. As expected, the car was found to be the dominant travel mode for tours performed outside the neighbourhood. The absence of public transport and lack of school buses led to the car becoming the household's favourite travel mode. The cultural environment also affected household travel behaviour in several ways. First, women are not allowed to drive cars, so they have to depend on adult male members of the household, mainly the household head, to perform their travel needs, or a chauffeur has to be employed. Second, to fulfil household members' spiritual needs, tours to the mosque was the most frequent travel purpose, almost a quarter of all tours ended at mosques.

Household characteristics, such as number of employees and number of drivers, were found to influence travel behaviour. Regarding the association between neighbourhood characteristics and travel behaviour, it was found that neighbourhoods varied in their associated travel behaviour (i.e. travel complexity and travel mode), due to neighbourhoods' physical design (i.e. density, design, and land uses) and variation between residents' socio-economic characteristics.

A trip generation model was calibrated and reported in Chapter Six. To determine the factors affecting the trip generation rate, a Poisson Regression model was employed with the number of car trip legs per household as the dependent variable. Results indicated that trip generation rates were influenced by household head characteristics, household attributes, and neighbourhood characteristics. The household head's occupation significantly influenced trip rate, due to flexibility and income effects. Car ownership, number of adult males able to drive, and availability of a chauffeur increased the household's ability to perform car trips. Number of females in employment and number of children were significant variables with a positive sign influence as they need to be escorted to/from the workplace and schools. Low income group, number of children less than 6 years old, and number of household members not employed were significant variables with a negative sign influence. Neighbourhood density was the only significant variable among neighbourhood characteristics. Residents in high density areas tended to undertake less car trips, due to the availability of services and shops within walking distance. This is consistent with the findings of Newman and Kenworthy (1989), Ewing et al. (1994), Cervero (1996), Banister (1999), and Kirzek (2003) who comment that:

> *"Households who live in areas with higher neighbourhood accessibility are more likely to make tours with a fewer number of stops" (p. 402).*

Travel to work was analysed in detail in chapter seven, in order to understand what implications household heads' attributes, household socio-economic and neighbourhood characteristics had on the household head's decision to structure his work tour. The MNL model application confirmed that a range of variables had a significant influence on tour type. The propensity to select a journey to work tour type depended on the household head's characteristics, such as income, occupation, education, and employment sector. Household heads with a high income tended to perform more complex tours, probably because those who are self-employed and running their own business enabled them to perform other activities en route to and from work. Household heads with lower socio-economic status, i.e. lower educational background and unskilled occupation, were more likely to be involved in simple tours because of their low participation in serving their household members' travel needs due to their residency in high density areas where people tend to walk to their destinations, especially students. In addition, the household head's employment sector (civil service, military, and private sector) significantly influenced journey to work tour type, probably because of the variations between these sectors as regards the flexibility of working hours within these sectors. Employees in the civil services generated more complex journeys to and from work because of their ability to leave within working hours.

Distance to work was found to be significant in the structure of the associated tour. Increase in distance travelled to work decreased the probability of involvement in complex work tours. Those whose workplaces were near their homes were more involved in complex tours, especially complex mid-day tours from the workplace to schools to pick children up to take them home and then return to the workplace.

Additionally, household characteristics were found to have a significant influence on household heads' work tour type decision. Not surprisingly, when household car ownership increased, the household head's propensity to involvement in complex work tours decreased. This might be because responsibility for serving household members' travel needs was shared by other persons. e.g. adult males or a chauffeur. This finding is consistent with that in the work of Krizek (2003).

The cultural environment effect was observed when examining the association between female students in the household and complex tours, because household heads tended to escort female students to and from school. Its effect was also observed when investigating the association between females in employment and complex tours. The more females in employment in the household, the more complex was the household head's work tour.

From the research findings, neighbourhood residential density significantly influenced tour type. Residents in high density areas were more likely to undertake simple tours to work than residents in low density areas because the former have access to more services, e.g. educational services. Thus, among children, more boys than girls tended to travel on their own to school due to the short walking distance from home, resulting in simpler tours to work.

The MNL model for work tour type results supported the study's working hypothesis that household characteristics, the cultural environment, and the built environment will influence household travel decisions. Household socio-economic characteristics were the most significant factors (the household head's occupation, education, income, household size, car ownership and availability of a chauffeur), and cultural factors, such as the number of females in school and number of females in employment, were also significant. Built environment characteristics, such as density

and distance to work, were similarly significant. However, factors such as distance to services (mosque, schools) proved to be insignificant in the journey to work tour types model.

The research also conducted semi-structured interviews with household heads to identify opportunities and constraints on household travel decisions. Household characteristics, household head's job attributes, safety and weather were revealed to be the main factors influencing travel behaviour. Analysis of interviewees' responses revealed the most commonly cited obstacles/ constraints on household travel decision were:

a) Lack of school transport

b) Unreliable, inadequate bus service

c) The car oriented built environment.

d) The service provision pattern

e) Ignorance of females' travel needs by local authorities, public transport providers, and employers of female

f) The weather

These obstacles can be viewed as two types: first, obstacles that can be dealt with through appropriate policy action, namely, lack of school transport, poor public bus service, car-oriented built environment, and an inefficient service provision pattern; and, second, obstacles arising from cultural and environmental factors, such as ignorance of females' travel needs and the weather. The most influential obstacles affecting household travel decisions were the first type, and mainly the lack of school transport.

10.2.2 The second objective: to identify the likely response to specific transport policies

To address this objective, the study proposed five policies related to household travel decisions, and interviewees were asked to identify their likely impacts on their travel behaviour. The policies were related to the spatial distribution of services, the introduction of new transportation systems, and the improvement of existing ones. The aim of these policies is to reduce households' car dependency. Interviewees strongly supported the introduction of most of the new policies to overcome the obstacles facing Saudi households' travel behaviour. It is important to note that although the study used stated intention, the study did not examine participants' willingness to pay for the proposed new schemes and facilities. Further investigation is needed to evaluate the economic feasibility of such policies and alternative methods of funding such services. The five proposed policies are:

- Introducing service centres within walking distance from home
- Introducing safe pedestrian paths to existing services
- Provision of safe and cheap school buses
- Provision of an accessible, reliable and cheap female-only public transport service
- Provision of work-based transport for female employees

The research findings suggested that if the proposed policies were applied, car trips might be cut by up to 26% (the percentage of car trips in 380 surveyed households undertaken to serve children to and from school and female members to and from the workplace); and the current average number of daily car trips of 9 car trips per household would be cut to 7 car trips per household. Introducing service centres within walking distance would be the most effective policy of all five policies

presented to interviewees to reduce motorised journeys, since this policy would enable children to travel on their own to school.

The study identified two major factors to which transport planners should pay special attention when proposing new transportation policies. First, households are highly dependent on adult males to perform their travel activities and, secondly, the high priority given to women's privacy in the Saudi context.

10.3 The contributions of the research

Urban development in Saudi cities has led to increasing attention being paid to urban transportation in order to address environmental and economic problems arising from traffic congestion. Thus, travel behaviour studies, particularly of travel patterns in Saudi cities, are important so that major cities, which have modern world class infrastructures, continue to function effectively and their citizens enjoy a healthy environment. To achieve these objectives there is a need to develop a database of travel characteristics in cities, and conduct travel surveys (on travel purpose, time, travel mode), to produce detailed travel statistics. These efforts will form the basis for further investigation to achieve better understanding of travel behaviour. The present study attempted to investigate different aspects of travel behaviour by focusing on household travel characteristics. The main contributions of this research are, accordingly, as follows:

- An analysis of travel within an activity-based framework in a different cultural environment, i.e. an Islamic culture, which differs in many ways from the Western environment.
- This study used both quantitative and qualitative methods according to data analysis requirements. Quantitative analyses varied from descriptive analysis

to more complex travel modelling approaches. Qualitative data were used to increase knowledge of household travel decisions.

- The study has provided a rich database of travel behaviour in a Saudi city, Dammam. The primary data were collected from household travel diaries and details included: travel purpose, travel mode, travel time, traveller details, number and type of passengers, secondary stop purposes, number of trip legs, and type of work tour. The study has therefore provided a varied range of travel behaviours across neighbourhoods, and contributed a useful source of information for planners and researchers dealing with travel behaviour in the country. The study has implemented a statistical methodology for analysing trip generation rates and commute tour types. Poisson regression and multinomial logit models have been utilised in ways that accommodate the Saudi context. The study has confirmed that the tour-based model is a very useful complement to a standard trip generation model for analysing work travel in Saudi cities, because it identifies and provides a fuller understanding of the links between activities. The study results identified factors shaping household travel behaviour in Dammam, a major Saudi city, and provided useful data about the travel characteristics of its citizens. Dammam is a metropolitan area comprising the three cities of Dammam, Khobar, and Dhahran, which impact on residents' travel pattern. They tend to travel from one city to another, which means the average distance travelled within the Dammam area is longer than in other Saudi cities, especially medium size cities. While individual cities will be characterised and influenced by their distinct socio-economic, demographic and land use-transport variables which will merit detailed study, the actual influence on trip generation and work tour

structure may well show distinct similarities across cities. It is therefore believed that this study has made a useful contribution to travel studies in Saudi and Islamic cities.

10.4 Limitations of the study

Due to limitations of time and resources, this study has examined the travel behaviour of Saudi households based on a 24-hour travel diary. A travel diary over a week would have elicited more travel activity details and facilitated in-depth exploration of variation between weekdays. For example, a few household heads who worked shifts were off duty on the day travel dairies were recorded, so travel to work activity did not appear in their diaries, thus an incomplete record of their travel activities over a weekday was produced.

Additionally, due to time constraints, the travel diary was obtained by interviewing the household head only. He was asked to give the travel details for all household members. Ideally, travellers themselves should have been asked for details of their travel activities to minimise the omission of some travel activities. Further, and importantly, due to cultural constraints, it was impossible for the researcher (a male) to interview female members of the household. Although this means that only the household head's opinion and attitude was obtained, which may not have totally reflected other household members' opinions and attitudes, nevertheless, it is believed that the household head will have accurate knowledge about, and broadly reflect, other household members' travel needs and activities. This, however, remains an untestable hypothesis.

Although Saudi Arabia has particular cultural and social traditions which distinguish it from some other Islamic countries (e.g. the prohibition on women

driving cars) it is believed that many features of the above analysis will be transferable to other Islamic contexts. This aspect would repay further study.

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Appendix 1:

Copy of Questionnaire Form
(in English and Arabic Forms)

Interview Detail

Case Number: _____

Interviewer Name:_____

House No.:

Interview Time:

Date:

Day : 1- Sunday 2- Monday 3- Tuesday 4- Wednesday 5- Thursday

Interview

Part 1: Household head information:

1.1. How old are you? _____

1.2. What is your level of education?
1- Illiterate 2- Can read and write 3- Primary school 4- Intermediate school
5- Secondary school 6- Technical institute 7- University graduate 8- Postgraduate

1.3. What is your occupation?
1- Professional 2- Administrative 3- Businessman 4-Workman 5-Retired
6-Student 7- Unemployed 8-Other (Please specify):.....

1.4. What is your employment sector?
1- Civilian work 2- Military 3- Private sector 4- Own business

1.5. What are your working hours?
1- 7:30 am –2:30 pm 2- 7:00 am –3:30 pm 3- 8:00 am –4:00 pm
4- Changeable shift: please specify your present working hours..... 5- Others:.....

1.6. What is your monthly income?(Saudi Riyals)
1- Less than 3000 2- 3000- less than 5000 3- 5000 – less than 7000
4- 7000-Less than 9000 5- 9000- less than 11000 6- 11000-Less than 15000
7- 15000 and more

Part 2: Household characteristics:

2.1. No. of persons available to drive:.....

2.2. Availability of chauffeur: 1- Yes 2- No

2.3. No. of cars:.....

2.4. Housing tenure: 1- Own house 2- Rent 3- Provided by employer

2.5. No. of household members under age of 6 years old :.....

2.6. Household structure: (not include the household head and members under 6 years old)

No.	Age	Gender	Relationship to head of household	occupation	If student specify school's level	If employee specify employment sector
1		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 2- Administrative 3- Workman 4- Retired 5- Student 6- Housewife 7-Unemployed 8- Other (Please specify):.....	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.
2		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 2- Administrative 3- Workman 4- Retired 5- Student 6- Housewife 7-Unemployed 8- Other (Please specify):.....	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.
3		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 2- Administrative 3- Workman 4- Retired 5- Student 6- Housewife 7-Unemployed 8- Other (Please specify):.....	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.
4		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 2- Administrative 3- Workman 4- Retired 5- Student 6- Housewife 7-Unemployed 8- Other (Please specify):.....	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.

5		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 4- Retired 7-Unemployed	2- Administrative 5- Student 8- Other (Please specify):.....	3- Workman 6- Housewife	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.
6		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 4- Retired 7-Unemployed	2- Administrative 5- Student 8- Other (Please specify):.....	3- Workman 6- Housewife	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.
7		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 4- Retired 7-Unemployed	2- Administrative 5- Student 8- Other (Please specify):.....	3- Workman 6- Housewife	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.
8		1-Female 2- Male	1-Wife 2-Son 3-Daughter 4- Other Please specify.....	1- Professional 4- Retired 7-Unemployed	2- Administrative 5- Student 8- Other (Please specify):.....	3- Workman 6- Housewife	1- Elementary 2- Interm 3- Secondary 4- College	1- Civil 2- Military 3- Private sec. 4- Own bus.

3- Travel diaries

3-1 Travel diary of car no. 1

Car main user: 1- Household head
2- Household member (Please specify the relation to the household head) ....
3- Chauffeur

Please remember that each stop at place account as separate trip

Trip period	Leg no.	Who was the driver?	Where did the trip start?	What time did the trip start?	Where did the trip end?	Trip purpose	Who was with the driver?
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	

3-2Travel diary of car no. 2

Car main user:
1- Household head
2- Household member (Please specify the relation to the household head) ....
3- Chauffeur

Please remember that each stop at place account as separate trip

Trip period	Leg no.	Who was the driver?	Where did the trip start?	What time did the trip start?	Where did the trip end?	Trip purpose	Who was with the driver?
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:.........				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	

3-3 Travel diary of car no. 3

Car main user: 1- Household head
2- Household member (Please specify the relation to the household head) ……..
3- Chauffeur

Please remember that each stop at place account as separate trip

Trip period	Leg no.	Who was the driver?	Where did the trip start?	What time did the trip start?	Where did the trip end?	Trip purpose	Who was with the driver?
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	
1-Morning Trips 2-Trips Within working hours 3-Trips After work 4-Evening Trips		1-Main user 2-Other:………				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure	

4- Walking trips

Did any household member walk to his/her destination(s)? ☐ Yes ☐ No If yes…

Who was the traveller?	What time did the trip start?	Where did the trip start?	Where did the trip end?	Trip purpose
				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure

5-Other travel modes:

Did any household member use other travel modes than household cars or walking? ☐ Yes ☐ No If yes…

Who was the traveller?	Travel mode	What time did the trip start?	Where did the trip start?	Where did the trip end?	Trip purpose
	1-Driven by a relative or neighbour 2- Driven by friend 3- Public bus 4- School bus 5- Taxi or Minibus 6- Transport provided by employee				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
	1-Driven by a relative or neighbour 2- Driven by friend 3- Public bus 4- School bus 5- Taxi or Minibus 6- Transport provided by employee				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
	1-Driven by a relative or neighbour 2- Driven by friend 3- Public bus 4- School bus 5- Taxi or Minibus 6- Transport provided by employee				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
	1-Driven by a relative or neighbour 2- Driven by friend 3- Public bus 4- School bus 5- Taxi or Minibus 6- Transport provided by employee				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure
	1-Driven by a relative or neighbour 2- Driven by friend 3- Public bus 4- School bus 5- Taxi or Minibus 6- Transport provided by employee				1- home 2- work 3- education 4- mosque 5- shop 6- social 7- leisure

6- Please show all household destinations during the last 24 hours in attached maps.

7- the study includes an in-depth interview to understand the nature of travel decision within Saudi households, <u>do you like participate in next stage so the researcher can interview you?</u> 1- Yes 2- No

بيانات خاصة بالمقابلة

أسم الطالب:

الحي:

رقم المنزل: رقم الشقة:

وقت إجراء المقابلة (الساعة):

اليوم: ١- الأحد ٢- الأثنين ٣- الثلاثاء ٤- الأربعاء ٥- الخميس

التاريخ:

١-معلومات متعلقة برب الأسرة:

١-١ العمر: ________

١-٢ المستوى التعليمي:

١- أمي ٢- يقرأ ويكتب ٣- الشهادة الابتدائية ٤- الشهادة المتوسطة ٥- الشهادة الثانوية

٦- تعليم فني ٧- جامعي ٨- دراسات عليا

١-٣ المهنة:

١- مهني ٢-إداري ٣- رجل أعمال ٤- عامل ٥- حرفي

٦- طالب ٧- يبحث عن عمل ٨- أخرى : حدد________

١-٤ قطاع العمل:

١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة

١-٥ ساعات العمل:

١- ٧:٣٠ - ٢:٣٠ ظهرا ٢- ٧:٠٠ - ٣:٣٠ ظهرا ٣- ٨:٠٠ - ٤:٠٠ عصرا

٤- دوام على فترتين: الفترة الأولى من :_____ الى:_____ الفترة الثانية من:_____ الى:_____

٥- دوام على نظام المناوبة المتغيرة : حدد ساعات العمل لليوم السابق لا جراء المقابلة________ ٦- أخرى : حدد________

١-٦ الدخل الشهري (ريال سعودي):

١- أقل من ٣٠٠٠ ٢- من ٣٠٠٠ - أقل من ٥٠٠٠ ٣- من ٥٠٠٠ - أقل من ٧٠٠٠

٤- من ٧٠٠٠ - أقل من ٩٠٠٠ ٥- من ٩٠٠٠ - أقل من ١١٠٠٠ ٦- ١١٠٠٠ أو أكثر

٢-معلومات متعلقة بالأسرة:

٢-١ عدد أفراد الأسرة القادرين على قيادة السيارة : ________

٢-٢ عدد السيارات: ________

٢-٣ وجود سائق: ١- نعم ٢- لا

٢-٤ ملكية المسكن: ١- ملك ٢- مستأجر ٣- سكن خاص بجهة العمل

٢-٥ عدد أفراد الأسرة الأقل من ستة سنوات: ________

٢-٦ تركيبة الأسرة : خصائص أفراد الأسرة البالغة أعمارهم ستة سنوات وما فوق:

الرقم	العمر	الجنس	العلاقة برب الأسرة	المهنة	إذا كان طالب في أي مرحلة	إذا كان موظف في أي قطاع
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد____	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد____	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد____	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد____	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة

الرقم	العمر	الجنس	العلاقة برب الأسرة	المهنة	إذا كان طالب في أي مرحلة	إذا كان موظف في أي قطاع
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة
		١-ذكر ٢- أنثى	١- زوجة ٢- ابن ٣- بنت ٤- أخرى حدد___	١- مهني ٢-إداري ٤- عامل ٥- حرفي ٦- طالب ٧- يبحث عن عمل ٨- أخرى : ___	١- ابتدائي ٢- متوسط ٢- ثانوي ٤- معهد او كلية	١- حكومي مدني ٢- عسكري ٣- قطاع خاص ٤- أعمال حرة

٣- جدول الرحلات الناشئة من الأسرة خلال اليوم السابق للمقابلة باستخدام السيارة رقم ١:

٣-١ المستخدم الرئيسي للسيارة :   ١- رب الأسرة   ٢- أحد أفراد الأسرة: حدد__________   ٣- السائق

٣-٢ جدول الرحلات المستخدمة للسيارة رقم ١: الرجاء مراعاة أن كل توقف في مكان يحسب رحلة مستقلة:

فترة الرحلة	رقم الرحلة	السائق	متى بدأت الرحلة	أين بدأت الرحلة	أين انتهت الرحلة	هدف الرحلة	من رافق السائق في الرحلة
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧- تر فيهي	

٣- جدول الرحلات الناشئة من الأسرة خلال اليوم السابق للمقابلة باستخدام السيارة رقم ٢:

٣-١ المستخدم الرئيسي للسيارة : ١- رب الأسرة ٢- أحد أفراد الأسرة: حدد__________ ٣- السائق

٣-٢ جدول الرحلات المستخدمة للسيارة رقم ١: الرجاء مراعاة أن كل توقف في مكان يحسب رحلة مستقلة:

فترة الرحلة	رقم الرحلة	السائق	متى بدأت الرحلة	أين بدأت الرحلة	أين انتهت الرحلة	هدف الرحلة	من رافق السائق في الرحلة
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧- تر فيهي	

٣- جدول الرحلات الناشئة من الأسرة خلال اليوم السابق للمقابلة **باستخدام السيارة رقم ٣**:

٣-١ المستخدم الرئيسي للسيارة : ١- رب الأسرة ٢- أحد أفراد الأسرة: حدد________ ٣- السائق

٣-٢ جدول الرحلات المستخدمة للسيارة رقم ١: الرجاء مراعاة أن كل توقف في مكان يحسب رحلة مستقلة:

فترة الرحلة	رقم الرحلة	السائق	متى بدأت الرحلة	أين بدأت الرحلة	أين انتهت الرحلة	هدف الرحلة	من رافق السائق في الرحلة
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي	
١- الصباح ٢- الى العمل ٢- خلال العمل ٣- الانصراف من العمل ٤- المساء		١- المستخدم الرئيسي ٢- آخر: حدد____				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧- تر فيهي	

٤- جدول الرحلات الناشئة من الأسرة خلال اليوم السابق للمقابلة <u>مشيا على الأقدام</u>:

٤-١ جدول الرحلات: الرجاء مراعاة ان كل توقف في مكان يحسب رحلة مستقلة:

رقم الرحلة	رقم الشخص المشغل	متى بدأت الرحلة	أين بدأت الرحلة	أين انتهت الرحلة	هدف الرحلة
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي
					١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧ - ترفيهي

٥- جدول الرحلات الناشئة من الأسرة خلال اليوم السابق للمقابلة باستخدام وسائل نقل أخرى (غير سيارة الأسرة والمشي):

٥-١ جدول الرحلات: الرجاء مراعاة ان كل توقف في مكان يحسب رحلة مستقلة:

رقم الرحلة	من الشخص المتنقل	وسيلة الانتقال	متى ابتدأت الرحلة	أين ابتدأت الرحلة	أين انتهت الرحلة	هدف الرحلة
		١- راكب مع قريب ٢- راكب مع صديق ٣- النقل الجماعي ٤- حافلة المدرسة ٥- حافلة خاصة ٦- سيارة أجرة ٧- نقل خاص بالعمل				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧- ترفيهي
		١- راكب مع قريب ٢- راكب مع صديق ٣- النقل الجماعي ٤- باص المدرسة ٥- باص خاص ٦- سيارة أجرة ٧- نقل خاص بالعمل				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧- ترفيهي
		١- راكب مع قريب ٢- راكب مع صديق ٣- النقل الجماعي ٤- باص المدرسة ٥- باص خاص ٦- سيارة أجرة ٧- نقل خاص بالعمل				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧- ترفيهي
		١- راكب مع قريب ٢- راكب مع صديق ٣- النقل الجماعي ٤- باص المدرسة ٥- باص خاص ٦- سيارة أجرة ٧- نقل خاص بالعمل				١- الذهاب الى البيت ٢- العمل ٣- التعليم ٤- الصلاة ٥- التسوق ٦- اجتماعي ٧- ترفيهي
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٦- يطلب من رب الأسرة تحديد المواقع التي انتقل اليها افراد الأسرة في الأمس وذلك على الخرائط المرفقة.

٧- هل ترحب بان يتصل بك الباحث للحصول على مزيد من المعلومات : ١- نعم ٢- لا

Appendix 2:

Copy of Semi-Structured Interview Form

Stage 2: Proposed policies

Given the following alternatives:

Policies	**Is it going to cut down no. of car trips?**	**If negative How this policy can be developed to attract users. If positive what do you like in this policy:**
Introduce service centres within walking distance from home (schools, mosques, shops)	☐ Strongly agree ☐ Agree ☐ I don't know ☐ Disagree ☐ Strongly disagree	
Introduce a safe pedestrian path to existing services (schools, mosques, shops)	☐ Strongly agree ☐ Agree ☐ I don't know ☐ Disagree ☐ Strongly disagree	
Provision of an accessible, reliable, and cheap female only public transport service	☐ Strongly agree ☐ Agree ☐ I don't know ☐ Disagree ☐ Strongly disagree	
Provision of schools buses: safe and cheap	☐ Strongly agree ☐ Agree ☐ I don't know ☐ Disagree ☐ Strongly disagree	
Provision of employees buses for female employers	☐ Strongly agree ☐ Agree ☐ I don't know ☐ Disagree ☐ Strongly disagree	

Second: Show the impact of each alternative on your travel activities

Alternative	Would it affect your household travel behaviour?	Impact on travel by car	Impact on travel by foot	Impact on travel other travel modes
A	1- Yes 2-No			
B	1- Yes 2-No			
C	1- Yes 2-No			
D	1- Yes 2-No			
E	1- Yes 2-No			

تأثير السياسات المقترحة على نمط الرحلات الحالي:

السياسة المقترحة	هل السياسة المقترحة ستؤدي الى تغير في نمط رحلات الأسرة؟ (وسيلة النقل، عدد التوقفات، مواعيد الرحلات)	ما طبيعة التغير في نمط الرحلات
١- إيجاد مراكز خدمة تحتوي على الخدمات الاجتماعية (مسجد، مدارس، بقالة) على مسافة المشي من البيت	١- نعم ٢- لا	
٢- توفير ممرات مشاة آمنة الى الخدمات المتوفرة حاليا (مسجد، مدارس، بقالة)	١- نعم ٢- لا	
٣- تقديم خدمة نقل عام خاصة بالنساء فقط سهلة الوصول، آمنة، ورخيصة	١- نعم ٢- لا	
٤- توفير خدمة النقل المدرسي: خدمة آمنة ورخيصة	١- نعم ٢- لا	
٥- إلزام جهات عمل النساء بتوفير حافلات لنقل الموظفات مقابل مبلغ رمزي	١- نعم ٢- لا	

المرحلة الثانية: السياسات المقترحة

السياسة المقترحة	هل السياسة المقترحة ستؤدي الى تقليل عدد رحلات السيارة في الأسرة السعودية؟	إذا كانت الإجابة غير مؤيدة للسياسة ، ماهي الشروط الواجب توفرها في البديل حتى يؤدي النتيجة المأمولة (بحث أي ظروف ستنجح السياسة)، إذا كانت الإجابة مؤيدة فماهي أسباب تأييدك لهذه السياسة؟
١- إيجاد مراكز خدمة تحتوي على الخدمات الاجتماعية (مسجد، مدارس، بقالة) على مسافة المشي من البيت	١- أوافق بشدة ٢- أوافق ٣- لا أدري ٤- لا أوافق ٥- لا أوافق بشدة	
٢- توفير ممرات مشاة آمنة الى الخدمات المتوفرة حاليا (مسجد، مدارس، بقالة)	١- أوافق بشدة ٢- أوافق ٣- لا أدري ٤- لا أوافق ٥- لا أوافق بشدة	
٣- تقديم خدمة نقل عام خاصة بالنساء فقط سهلة الوصول، آمنة، ورخيصة	١- أوافق بشدة ٢- أوافق ٣- لا أدري ٤- لا أوافق ٥- لا أوافق بشدة	
٤- توفير خدمة النقل المدرسي: خدمة آمنة ورخيصة	١- أوافق بشدة ٢- أوافق ٣- لا أدري ٤- لا أوافق ٥- لا أوافق بشدة	
٥- إلزام جهات عمل النساء بتوفير حافلات لنقل الموظفات مقابل مبلغ رمزي	١- أوافق بشدة ٢- أوافق ٣- لا أدري ٤- لا أوافق ٥- لا أوافق بشدة	

Appendix 3:

A Letter from the Dean of the College of Architecture and Planning, King Faisal University, to introduce interviewees to the research aim and assure them of the confidentiality of data provided.

KINGDOM OF SAUDI ARABIA
Ministry of Higher Education
KING FAISAL UNIVERSITY

المملكة العربية السعودية
وزارة التعليم العالي
جامعة الملك فيصل

الرقم :　　التاريخ :　　المرفقات :

أخي المواطن : السلام عليكم ورحمة الله وبركاته ،، وبعد

الاستبيان الذي بين يديك هو أحد مكونات بحث رسالة دكتوراه تهتم بدراسة خصائص الرحلات الناشئة عن الأسرة السعودية في مدينة الدمام .

نأمل منك أخي المواطن التكرم بمساعدة الباحث بالإجابة على الأسئلة الواردة في الاستبيان ، علما بأن المعلومات التي ستدلي بها ستستخدم للأغراض التعليمية فقط ، وتحاط بسرية تامة .

شاكرين ومقدرين لكم سلفا حسن تعاونكم ،،،،

عميد كلية العمارة والتخطيط
د. سعيد بن أحمد العويس

الأحساء - ص . ب ٤٠٠ - تلكس ٨٦١٠٢٩ فيصل أس جي - تليفون ٥٨٠٠٠٠٠ - فاكس ٥٨٠١٢٤٣ - الدمام - ص . ب ١٩٨٢ - تلكس ٨٧١٢٠٢ فيصل أس جي - تليفون ٨٥٧٧٠٠٠ - فاكس ٨٥٧٨٠٤٨
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