An examination of passenger surface access travel behaviour

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Abstract

The increasing scale of, and demand for, civil air transport has necessitated ever greater numbers of passengers and staff travelling to and from airports. At airports worldwide, private vehicles represent the vast majority of these surface access journeys and this has led to severe problems of traffic congestion and raised levels of air pollution.

Consequently, UK and international airports are re-evaluating their approach to surface access mode choice and considering how to reduce the reliance on private vehicles. Despite improvements in public transport links at some airports, in the UK it is currently estimated that around 65% of surface access trips at large airports are undertaken in private cars, with this figure being as high as 99% at smaller regional or secondary airports. The problems associated with high private vehicle use are likely to become even more acute in the future given the forecasted growth in demand for UK air travel.

Surface access is a complex airport management issue as decision makers must balance the often competing requirements and demands of different user groups with the wider commercial and environmental goals of the airport. Passengers pose a particular problem due to the large number of trips generated, and the wide range of factors affecting their travel. Passengers are also important because they represent the airport's primary customers.

The aim of the thesis is to examine passenger surface access travel behaviour in order to make recommendations for reducing private vehicle use. The research adopts a social psychological approach, employing two theories of attitude-behaviour relations, the Norm-Activation Theory and the Theory of Planned Behaviour, in order to identify groups of passengers with the potential to reduce their private vehicle use. Research methods employed to fulfil the aim include interviews with surface access managers at UK airports and a questionnaire survey of passengers at Manchester Airport, an international airport in the North-West of England.

It is found that passenger mode choice decisions are motivated primarily by considerations of self-interest, as posited in the Theory of Planned Behaviour, rather than normative or moral elements, as proposed by the Norm-Activation Theory. As well as attitudes, passengers are also found to vary considerably in terms of their specific personal, situational and spatial characteristics. For example, passengers using public transport are likely to be travelling alone from areas further from the airport and flying without checked-in luggage. Using this combined attitudinal, situational and spatial information, eight distinct passenger groups are then identified. Two of these groups, described as the *Public Transport Advocates* and the *Pessimistic Lift Seekers,* are found to have the greatest potential to reduce their private vehicle use.

Overall, it is important that strategies targeted at reducing private vehicle use and encouraging public transport use address both the physical and perceived barriers preventing behavioural change. Furthermore, while airport managers tend to favour implementing so called ‘soft’ incentive measures for encouraging modal shift as opposed to more draconian measures, in the future it is likely that decision makers will increasingly need to find ways of implementing the latter in a fashion that is both effective and acceptable to airport users.

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Publications

Earlier drafts of parts of this thesis have been published in journals, conference, and seminar proceedings.

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Chapter 1

Introduction

1.1 Background and context to the research problem

Addressing the environmental and social consequences of human transportation constitutes a major challenge for the twenty-first century. Increasing levels of personal mobility have resulted in significant adverse environmental, social and economic consequences for many regions, including increased levels of noise, visual intrusion, safety issues, traffic congestion, and higher levels of atmospheric pollution (Stradling et al., 2000; Cahill, 2010).

Owing to its very visible and well publicised environmental implications, commercial aviation has found itself at the forefront of developments to reduce emissions and reduce its environmental impacts. Yet while much research has focused on the environmental benefits of incremental improvements in engine fuel efficiency, aerodynamic performance and air traffic control, it is only recently that attention has turned towards reducing the environmental burden associated with (and resulting from) surface access journeys to and from airports.

In recognition of its environmental implications, and following increased public and political pressure to reduce carbon dependency and become more environmentally efficient, the aviation industry has set strict emissions targets and committed to reduce net global carbon emissions by 50% on 2005 levels by 2050 (IATA, 2009). Yet while aircraft emissions are perhaps the most familiar manifestation of the environmental externalities of the industry, aviation's environmental impact goes well beyond the aircraft themselves and permeates every stage of the service delivery chain (Upham et al., 2003; de Neufville & Odoni, 2003). One fundamental way in which the industry is seeking to improve its environmental performance is by encouraging people to travel to and from airports using more sustainable modes of transport. Given the high volume of journeys undertaken to and from airports worldwide by passengers, employees and freight, the role of surface access travel as an environmental issue is significant. For example, Coogan et al. (2008) estimate that an airport handling 45 million passengers per annum can generate up to five million miles of surface access travel every day.

1.2 The airport surface access problem

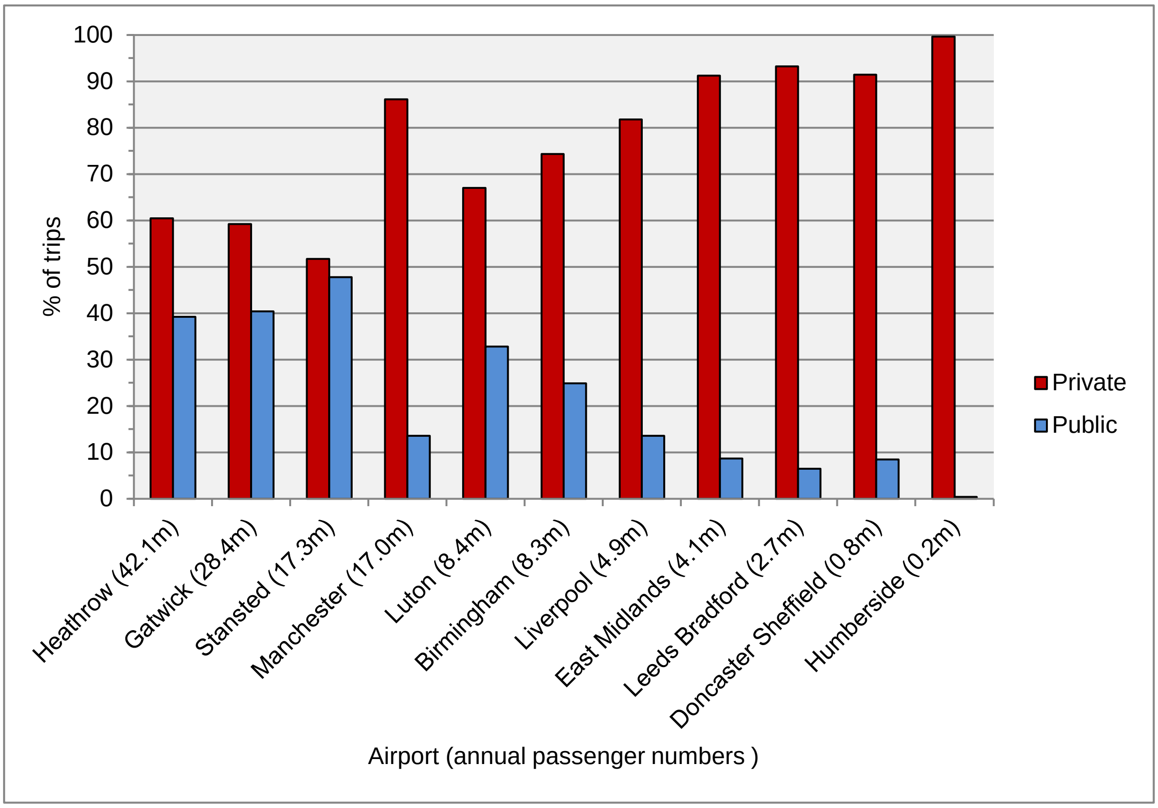
In the second half of the 20^{th} Century the growing scale and scope of civil air transport meant that airports had to accommodate ever growing numbers of people travelling to and from airports. Generally speaking, this meant accommodating the private car, with the design and construction of airport terminals driven primarily by the needs of private vehicle users. While this car-dominated airport surface access regime was appropriate for the increasingly affluent, oil-fuelled mobility of the 1950s and 1960s, the oil crises of the 1970s, combined with increased environmental awareness during the 1980s (as epitomised by the Bruntland report on sustainability in 1987 (United Nations, 1987)) and growing dissatisfaction with the economic disbenefits associated with increasing levels of delay and traffic congestion, resulted in airports worldwide beginning to re-evaluate travel mode choice and consider how to reduce reliance on private vehicle use.

While the concept of providing public transport to and from airports was not new, public and political pressure to invest in public transport increased markedly from the mid-1990s onwards. Nowhere was this more apparent than in the United Kingdom, where by the mid-1990s planning permission to expand UK airports was increasingly being predicated on new and improved public transport provision and investment (Coogan et al., 2008). At the same time, growing trends towards commercialisation and privatisation meant that UK airports began to recognise that in order to attract new airlines to their facilities they had to enable easier access and onward distribution of passengers and goods by surface modes of transport (Freathy, 2004).

As a consequence, UK airports, like equivalent facilities overseas, particularly in Scandinavia and other countries of Western Europe, began to improve public transport links and invest in new infrastructure. In the UK, new railway lines, spurs, and/or stations were constructed at Heathrow Airport, Manchester Airport, and Luton Airport Parkway (Sharp, 2006). New operating companies, including the premium rail brand Heathrow Express, which opened in 1998 and connected the airport to London's Paddington station, were established and subsidies for local bus services to and from airports were introduced (Coogan et al., 2008). However, while such initiatives have undoubtedly made some impact, private vehicle use remains relatively high at certain sites, especially smaller airports that cannot sustain the critical passenger mass needed to make public transport services viable (see Figure 1.1). Even at large airports, it is estimated that around 65% of surface access trips are undertaken in private cars, but this figure can be as high as 99% at smaller regional or secondary airports (Humphreys and Ison, 2005). The air quality implications of the reliance on private vehicles are significant. At Heathrow Airport, for example, estimates suggest that 80% of local air pollution is currently derived from surface access traffic and airside vehicles (Humphreys et al., 2005). Pollution levels from surface access traffic are particularly high around car parks and terminal buildings where vehicle movements tend to be more concentrated (Johnson, 1997).

On average, 64.3% of surface access trips to and from the largest UK airports are undertaken by private vehicles, whereas smaller airports such as Liverpool's John Lennon Airport and East Midlands Airport have private vehicle shares exceeding 80% and 90%, respectively. This has resulted in severe problems of traffic congestion on airport roads and consequently raised levels of vehicle emissions (Humphreys et al., 2005). This situation is likely to become even more acute in the future, given the forecasted growth in demand for UK air travel (Humphreys and Ison, 2005). Over the past 25 years UK passenger numbers have increased three fold to the point where 220 million passengers used UK airports in 2012 (CAA, 2013). Current forecasts indicate that passenger numbers may rise to 345 million passengers per annum (mppa) by 2030, and possibly as much as 400-700mppa by 2050 (DfT, 2011a).

In addition to the environmental implications, the continued reliance on private vehicles has important economic and revenue generating implications for airports. Providing efficient, reliable surface access travel is recognised as being a key customer service issue. Passengers who are faced with traffic congestion and increasingly unreliable journey times may choose to fly from other airports (Kazda and Caves, 2008).



Source: CAA, 2010

Figure 1.1 Mode split at UK airports

There is both a clear business and environmental case for airports to implement strategies that aim to reduce the share of journeys by private vehicles. At the same time, UK government policy requires airports to set medium and long term targets for achieving modal shift of passengers and employees towards public transport. This is by no means a simple task for airport decision makers, who must reconcile the myriad of complex and sometimes conflicting planning, commercial and environmental dimensions of surface access. As a result, surface access is recognised as being “*perhaps one of the most difficult problem areas to face airport management*” (Ashford et al., 2013, p411).

A key challenge for airport decision makers involves accommodating the varying requirements and characteristics of different airport users who each require different outcomes and consequently place differing demands on the system (Ashford et al., 2013; de Neufville and Odoni, 2003). Passengers, who typically represent the majority of surface access trips, are normally time sensitive and require a mode that is affordable, efficient and reliable (DfT, 2007). Employees, on the other hand, will make more frequent, regular trips to and from the airport, but often need to travel at times of the day poorly served by alternative modes (Ricard, 2012). The inherent nature of surface access also makes it a challenging management issue. For example, it is common for passengers to be dropped-off/picked-up by a friend or relative at the airport, which generates extra vehicle traffic (de Neufville and Odoni, 2003). Air travel is also unusual in that airline passengers are likely to be staying away for relatively long periods of time, travelling in groups and carrying heavy luggage with them (Ashford et al., 2013). Passengers are also important because they represent the airport's primary customers.

While transport policy in the UK has traditionally accommodated increased travel demand through the construction of new infrastructure (Owens, 1995), it is increasingly being realised that it is no longer feasible to simply 'build our way out of trouble' (Cairns et al., 2008, p593). Recent years have seen a growing interest in the role of attitudinal and psychological factors in determining people's travel choices. Psychological factors including attitudes, norms and values influence travel behaviour by determining individual preferences for different routes, destinations or modes (see, Anable, 2005; Bamberg and Schmidt, 2003; Bamberg et al., 2007; Heath and Gifford, 2002). An appreciation of the psychological correlates of travel behaviour should thus enable behavioural change strategies to be developed to encourage the use of more sustainable modes (Cairns et al., 2008). Strategies that target people's attitudes and perceptions are generally considered to be more acceptable and less expensive to implement than legislative or technological interventions (Taylor and Ampt, 2003), and are most effective when they are targeted at specific, and well defined groups of people (Stradling et al., 2000; Anable, 2005).

There is thus a compelling need to better understand surface access travel behaviour from the perspective of both airport managers and current/potential service users, and obtain empirical data that can be used to inform current practice and make recommendations for the future.

1.3 Research aim and objectives

Given the scale and complexity of the surface access problem there is a need to address the issue of high private vehicle use to and from airports and the resulting problems of congestion and increased vehicle emissions. Although surface access incorporates a range of different user groups, issues relating to passenger travel are particularly complex given the high volume of trips generated (including additional journeys for dropping-off/picking-up passengers), and the presence of various mediating factors, such as travelling in a group or with heavy luggage, that can affect decision making. From an airport management perspective, the issue of passenger access also demands attention because this group represent the airport's primary customers.

Building on current research into airport surface access and travel behaviour, the thesis adopts an innovative and holistic approach to tackling the research problem by combining elements and techniques taken from social and behavioural psychology, airport management and transport policy.

The aim of this thesis is thus:

"To examine passenger surface access travel behaviour in order to make recommendations for reducing private vehicle use".

There are six research objectives, namely to:

1. identify key surface access issues.

2. understand the challenges, implications and future directions of surface access management.

3. assess the personal, situational and spatial characteristics of passenger mode choice.

4. evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles.

5. determine segments of passengers with the greatest potential to reduce their private vehicle use.

6. make recommendations to airport decision makers concerning effective strategies for reducing private vehicle use.

1.4 Structure of the thesis

The remainder of the thesis consists of eight distinct yet interrelated chapters.

Chapter 2: Literature review: identifying key surface access issues

A review of the literature is used to consider the political context from which the surface access problem has emerged. This is followed by a description of the varying requirements and characteristics of airport users, the geographic distribution of surface access traffic, the commercial needs of airport operators, and the role of external market conditions. The chapter also discusses various surface access management strategies in light of the topics raised.

Chapter 3: Scoping study: an airport management perspective

The review of the literature then forms the basis of a scoping study in Chapter 3. This consists of a number of interviews conducted with key personnel responsible for surface access management in the UK. These provide a valuable practitioner viewpoint on the challenges associated with surface access and help to expand on the literature by addressing some of the practical applications of surface access management. Through this, the scoping study acts to help guide the research.

Chapter 4: Theoretical underpinning: socio-psychological approaches to travel behaviour

Given an understanding of the topic area and the challenges faced by airport managers, Chapter 4 outlines the theoretical underpinning of the research. Socio-psychological approaches to travel behaviour are discussed largely in relation to two established theories of attitude-behaviour relations, the Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991).

Chapter 5: Research design and methods

The research design is developed in light of the ontological position of the researcher, the objectives of the study and the research strategy. These in turn are used to justify and describe the study site as well as the various methods employed in the data analysis.

Chapter 6: Assessing the personal, situational and spatial characteristics of passenger mode choice

This is the first of three chapters which use Manchester Airport as a case study for examining passenger surface access travel behaviour. Based on a questionnaire survey, descriptive analysis is used to assess the personal, situational and spatial dimensions of passenger mode choice. Following this, a statistical modelling technique is used to develop a broad typology of passengers based on these various characteristics.

Chapter 7: Evaluating the psychological antecedents of decisions to use alternative modes to private vehicles

Analysis in Chapter 7 considers the underlying attitudinal or psychological antecedents of decisions to travel to Manchester Airport by alternative modes to private vehicles. Psychological constructs included in the analysis relate predominantly to attitudinal and normative factors included in the Norm-Activation Theory and the Theory of Planned Behaviour, as discussed in Chapter 4.

Chapter 8: Determining passenger market segments with the potential to reduce their private vehicle use

Policies designed to initiate behavioural change are considered most effective when they are targeted at specific groups of people who share a set of common characteristics (Stradling et al., 2000; Anable, 2005). Subsequently, in Chapter 8 distinct market segments of passengers are determined based on shared attitudinal and situational characteristics and those with the greatest potential to reduce their private vehicle use are identified.

Chapter 9: Conclusions and recommendations

In the final chapter the main findings from the research are addressed. From these a number of policy recommendations are made for airport decision makers to help reduce the share of private vehicle journeys to airports in the future. The empirical and theoretical contributions of the research are discussed, the limitations of the study are acknowledged and possible areas for future research proposed.

Chapter 2

Literature Review

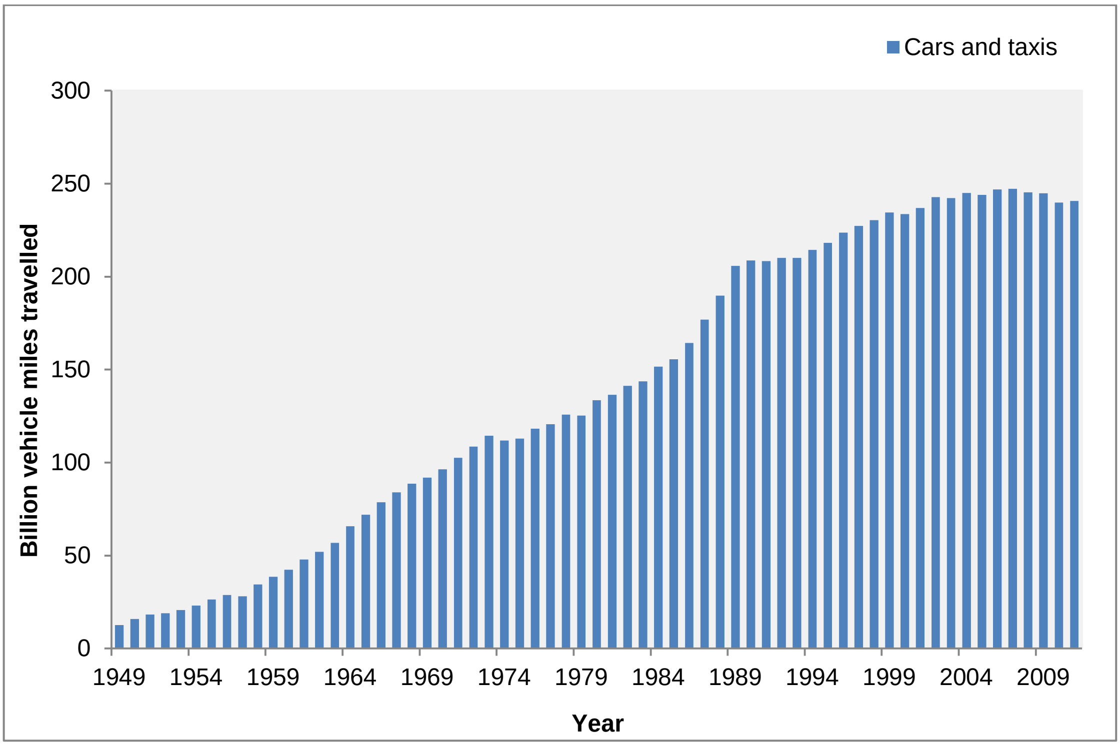
2.1 Introduction

The continued dominance of private vehicles for surface access travel has created significant problems for airports through increased traffic congestion and raised vehicle emissions (Humphreys and Ison, 2005). Consequently, there is a need for airport operators to reduce the share of private vehicle journeys. This is by no means a straightforward task for airport managers given the myriad of complex issues involved. In order to situate the present research in extant literatures and gain a better appreciation of the key issues, this chapter reviews available academic and practitioner literatures "to identify key surface access issues (objective 1)."

In order to synthesise a diverse body of literature, this chapter is divided into seven subsections. Section 2.2 provides a background to the research in terms of the political context from which the present surface access problem has emerged. Section 2.3 then addresses the issues posed by the varying requirements and characteristics of airport users who each place different demands on the system. In Section 2.4 the geographic distribution of surface access traffic is discussed. The commercial needs of airport operators and the effects of external market conditions are then considered in Sections 2.5 and 2.6, respectively. In Section 2.7 a range of strategic management options are reflected upon, covering both short and longer term strategies. The chapter concludes, in Section 2.8, by presenting the principal themes and research challenges that will be taken forward to inform the empirical research. Crucially, the literature review discovers there is currently little research concerning the attitudinal antecedents of surface access travel behaviour, which is significant given that initiating behavioural change is identified as being a key goal for achieving modal shift towards more sustainable forms of transport.

2.2 The policy context

The second half of the 20th Century in the UK was characterised by rapid increases in car ownership and use. Between 1950 and 2011 the number of licenced motor vehicles in the UK rose from approximately 4 million to over 34 million (DfT, 2012a). This inevitably resulted in significant increases in total vehicle miles travelled (VMT) over this period. In 2011 it was estimated that VMT from cars and taxis was 240.7 billion, compared with 12.6 billion VMT in 1949 (Figure 2.1).



Source: DfT, 2012a

Figure 2.1 Increase in VMT by cars and taxis, 1949-2011

As early as the 1960s it was recognised that the unrestricted growth of car use could not be sustained, particularly in urban areas where problems of congestion were likely to be most acute (Ministry of Transport, 1963). However, the political and philosophical approach of 'predict-and-provide', where transport demands were forecast and capacity shortfalls met through the provision of key infrastructure, such as new roads, persisted until the 1990s (Owens, 1995).

At this time the air transport industry in the UK was undergoing significant changes. The 1986 '*Airports Act'* (UK Government, 1986) introduced the legislative framework that would lead to the widespread privatisation of UK airports. The Act reflected the prevailing ideological approach of the Conservative UK Government towards privatisation and commercialisation, aiming as it did to reduce the financial burden of airports on local and central government ahead of forecasted future growth in demand for air travel (Humphreys, 1999). Under the new legislation the state owned British Airports Authority (BAA), who had been formed in 1966 to manage airports of strategic national importance, was fully privatised and any airport that generated a turnover of £1 million or more in two of the previous three years was transferred to private ownership (ibid, 1999). These airports were forced to apply for private capital to finance operations and search for auxiliary sources of revenue. A commercial business model began to replace the traditional utility model of airport management and so the role of the airport changed from a site that simply facilitated the routine movement of passengers and freight into a modern, money making enterprise driven by new commercial imperatives to generate profits and pay returns to shareholders (Francis et al., 2004; Freathy, 2004; Humphreys et al., 2007).

Other significant changes were also happening across Europe, as the aviation market underwent a process of progressive liberalisation, brought about by three successive legislative ‘packages’ in 1987, 1990 and 1993 (Graham, 2008). This regulatory reform removed previously restrictive regulations governing market entry and airfares and opened up the European airline market to new entrant carriers, who quickly began competing on price with the incumbent operators. In order to minimise costs, many of these new entrant carriers chose to eschew the expense and congestion associated with major hub airports and flew instead from cheaper secondary and/or regional airports. These low cost airlines (exemplified by easyJet and Ryanair) stimulated new demand for air travel within Europe and resulted in significant traffic growth at airports across Europe and the UK that had hitherto handled little by way of regular commercial traffic (Francis et al., 2006).

Towards the end of the 1990s there was a marked shift away from traditional ‘predict and provide’ philosophies concerning transport provision towards a more ‘demand management’ approach that emphasised the importance and value of using existing infrastructure more efficiently rather than continually accommodating demand through construction of infrastructure. In 1998, the new Labour Government published the White Paper ‘*A New Deal for Transport: Better for Everyone’* (DETR, 1998). This acted as a watershed for UK transport policy, heralding a shift towards a so-called ‘Integrated Transport Strategy’ for tacking congestion and pollution. It reflected what Goodwin et al. (1991) had termed a *‘new realist’* approach to transport policy, which emphasised the need to reduce the need for individual travel and encourage modal shift towards more sustainable modes. A key theme of the White Paper related to providing choices between modes, acknowledging that people make conscious decisions between different modes even when accounting for constraints such as car availability or cost.

The 1998 White Paper also marked the first formal recognition of the airport surface access problem in UK Government policy. As part of the commitment to developing integrated transport policies for tackling pollution and congestion, the White Paper required all UK airports handling over 1,000 annual air traffic movements to establish an Airport Transport Forum (ATF). These forums were to consist of a wide range of relevant stakeholders and were designed to foster greater partnerships between airport operators, local authorities, transport operators, passenger groups, local residents and businesses with the ultimate intention of reducing the reliance on private vehicles, congestion and pollution on surrounding roads.To achieve these goals, ATFs were made responsible for preparing an Airport Surface Access Strategy (ASAS). The main objectives of these ASAS were:

- To set challenging short and long term targets for decreasing the share of journeys by private, road-based vehicles, while increasing the share of trips by public transport.
- To devise strategies for achieving these targets by way of managing traffic on surrounding road networks and by promoting alternatives to the private car.
- To monitor and oversee the implementation of these strategies.

Source: DETR, 1998

ASASs were to include an analysis of existing surface access arrangements, outline a mix of short term actions and longer term proposals, offer an indication of the cost of proposed schemes, and detail a set of performance indicators for monitoring and assessing whether targets and objectives were being met (DETR, 1999). While there was no specific guidance on the frequency with which ASASs should be published, most airports have typically published one every 5-10 years. Examples of ASAS are shown in Figure 2.2.

Figure 2.2 Examples of Airport Surface Access Strategies (ASAS)

The specific nature and timescales of surface access targets were to be determined by the ATF. For example, when still in BAA ownership, London Stansted Airport set a target to achieve and sustain a 43% mode share of passengers using public transport by 2014 (BAA Stansted, 2008), whereas Manchester Airport (owned by Manchester Airports Group) aims to achieve a 40% mode share of passengers using public transport by 2030 (Manchester Airport, 2007). However, despite their laudable aims, the role of ATFs and ASAS has been challenged by some who suggest that there is often great variation in the detail, rigour and sophistication of the resulting targets.

Humphreys et al. (2005), suggest that a lack of common methodology in terms of feasibility, monitoring and appraisal of strategies limits their comparability across airports. Further questions have also been raised about the suitability of existing mode share targets, the metrics used to determine them, and the consequences for airports should they fail to meet them, since targets are set by the airport themselves and are not legally binding (Humphreys and Ison, 2002; Humphreys and Ison, 2005). As a consequence, the capability of ATF and ASAS to effect and maintain long term reductions in private vehicle journeys remains in question (Humphreys and Ison, 2002).

Following the publication of the 1998 White Paper, Government priorities appeared to focus more on policies for alleviating congestion rather than achieving overall reductions in traffic levels (Anable and Shaw, 2007). The ten year plan which was published in 2000, for example, did not refer explicitly to cutting traffic levels, only to reducing levels of congestion (DETR, 2000). To an extent the ten year plan also represented something of a return to the old philosophy of ‘building your way out of trouble' with the construction of new infrastructure justified on the basis of predicted travel-time savings for businesses and individuals (Hull, 2008).

In 2003, *'The Future of Air Transport',* White Paper, which outlined a policy framework for the development of UK airports to 2030, was published (DfT, 2003). As well as reiterating the need to reduce private vehicle trips and ease congestion at airports for environmental reasons, the White Paper also made it clear that future proposals for airport expansion projects had to ensure that appropriate strategies were put in place to minimise environmental impacts, lower congestion and reduce other deleterious local impacts of surface access travel. This was significant, as it explicitly coupled issues of surface access with the future development of airports.

> *"Ensuring easy and reliable access for passengers, which minimises environmental, congestion, and other local impacts, is a key factor in considering any proposal for new airport capacity. All such proposals must be accompanied by clear proposals on surface access which meets these criteria."*

DfT, 2003, p60

The need to explicitly deal with the impacts of surface access travel subsequently became a key issue for airport managers, not just for environmental reasons but for business reasons as well. For example, political and environmental approval for Heathrow's Terminal 5 was contingent, at least in part, on the airport operator reducing off-airport environmental impacts through investment of roughly £375 million in the Heathrow Express rail system (Coogan et al., 2008).

In 2003 the Government also published the Energy White Paper, *'Our energy future-creating a low carbon economy'* (DTI, 2003). One of the key elements of this document was an explicit commitment to reduce UK CO_2 emissions by 60% by 2050. Given that aviation was recognised at the time as being the fastest growing source of CO_2 of any sector in the UK economy (Anderson et al., 2005), there appeared to be a clear and seemingly irreconcilable conflict between future airport expansion on the one hand, and targets to reduce CO_2 emissions on the other (Bows and Anderson, 2007).

The focus on a more 'demand management' approach to transport policy in the UK persisted throughout much of the rest of the decade. An update to the 1998 White Paper (published in 2004 and entitled '*The future of transport')* promoted the use of public transport and non-motorised modes as providing a *'positive choice'* for individuals (DfT, 2004). The potential for achieving significant modal shift towards more sustainable modes was supported by research by Stradling (2003), which suggested that as many as 80% of all car journeys could be undertaken by alternative modes.

In accordance with this approach, recent years have witnessed an increasing interest in the use of policy options such as marketing, information provision, and tailored services to encourage people to reduce their car use and instead adopt more environmentally sustainable and efficient modes of transport. These measures are sometimes referred to as 'soft' or 'smarter choice' policy options as they are distinct from the so called 'hard' alternatives such as road pricing (Cairns et al., 2008).

In 2011, a further White Paper *'Creating Growth, Cutting Carbon: Making Sustainable Transport Happen'* was published (DfT, 2011b). As well as advocating improved traffic management and schemes such as car sharing to reduce congestion, the White Paper again emphasised the need to encourage the use of more sustainable forms of transport, or 'sustainable transport choices'. This would be achieved by developing new policies and/or packages of policies that would 'nudge' individuals into making more sustainable travel decisions. A key aspect of this related to the important role of personal attitudes and psychological outlooks in informing and configuring individual travel behaviour.

> "*Behaviour is usually determined by a number of inter-connecting factors, including structural, attitudinal and habitual factors…attitudes may be affected by knowledge and awareness of perceived social and cultural norms (for instance, even if individuals may benefit from changing behaviour they may be deterred from doing so because their peers do not) and by habit."*
>
> DfT, 2011b, p34

This focus on promoting 'smarter' choices was consistent with the UK Government's more general approach that favoured non-regulatory and non-fiscal measures for initiating behavioural change. In 2010, a subgroup of the House of Lords Science and Technology Committee was established. They were charged with investigating 'Behavioural Change', with specific reference to transport and health. Concurrently, the UK Government also created the 'Behavioural Insights Team'. The establishment of the unit was heavily influenced by the concept of 'nudge theory', the idea that people can be encouraged to make positive choices through incentives and social cues rather than through regulation and legislation (Thaler and Sunstein, 2008). The purpose of the unit has thus been described as *"finding intelligent ways to encourage people to make better choices for themselves"* (Science and Technology Select Committee, p32).

In 2011, the subgroup of the the House of Lords Science and Technology Committee published the results of their inquiry into behavioural change (Science and Technology Select Committee, 2011). One of the key areas covered by the report was the need to reduce private vehicle use. It concluded that 'nudging' alone was unlikely to be effective in changing behaviour, and that interventions were more likely to be successful when enacted as part of wider package of regulation and fiscal measures.

> *"Changing choice of transport mode is likely to require a range of interventions to change individual behaviour or attitudes, interventions to change the environment, and regulatory and fiscal measures."*

Science and Technology Select Committee, 2011, p59

In 2012, the Department for Transport published a *'Draft Aviation Policy Framework'* (DfT, 2012b), which sought to help establish a new sustainable policy framework for UK aviation. An overarching theme of the framework was the need to make more efficient use of existing airport capacity. Reducing the share of private vehicle journeys to airports and increasing the use of public transport was recognised as an important part of fulfilling this goal.

> *"High quality, efficient and reliable road and rail access to airports contributes greatly to the experience of passengers, freight operators and people working at the airport. Greater use of low carbon modes to access airports also has the potential to reduce CO_2 emissions, as well as leading to less congestion and improved air quality."*
>
> DfT, 2012b, p31

Improving rail access to larger airports is identified as being a key priority as it offers *"efficient and environmentally-friendly connections to airport, particularly for larger airports where passenger numbers are sufficient to justify fast and frequent services"* (DfT, 2012b, p31).

Given the prominent role of surface access in UK Government policy and the need to reduce the share of private vehicle journeys to airports, the present research is highly relevant. However, while the political context demonstrates the requirement for effecting behavioural change it cannot, of itself, be sufficient to produce the desired outcome. In order to effect change, political will needs to be coupled with an in-depth understanding of the complexities surrounding human behaviour and travel choice. Consequently, a social psychological approach to examining surface access travel behaviour is essential. The following sections address the main issues relating to surface access management; the varying requirements and characteristics of airport users, the geographic distribution of surface access traffic, the commercial needs of airport operators, and the effect of external market conditions.

2.3 The varying requirements and characteristics of airport users

A fundamental part of surface access management relates to accommodating the various groups of airport users who each place different demands on the system (Ashford et al., 2013). Surface access traffic has four major components; passengers, employees, visitors, and cargo (the latter of which incorporates supply, delivery and other commercial vehicles) (Ashford et al., 2013; de Neufville and Odoni, 2003). The relative split between these groups can vary considerably between airports and depends on factors such as airport size, the time of day, week and year, the airport's geographical location, and the types of air services it offers (Humphreys et al., 2005 Ashford et al., 2013). It is estimated, however, that at any one time each group constitutes at least 20% of the total access trips to an airport (de Neufville and Odoni, 2003). Airport user groups each have different characteristics and requirements with regards to their surface access travel. It is thus important that surface access strategies take into account these varying requirements and characteristics, which are presented in Table 2.1.

2.3.1 Passengers

Passengers make one journey to the airport for each flight they take and are conventionally classified as being either originating (outbound) or terminating (inbound) passengers (de Neufville and Odoni, 2003). Passengers who are changing (or transferring) between flights are not considered in a surface access context as they do not require travel to/from the airport (Leigh Fisher Associates et al., 2002). At major hub airports, such as London Heathrow, the proportion of transferring passengers will be higher than at other airports.

Table 2.1 Typical requirements and characteristics of airport users

User category	Typical surface access requirements and characteristics
Passengers	- Represent the majority of surface access trips. - High private car use and use of drop-off/pick-up. - Time sensitive, and require a mode that is affordable, efficient, reliable, comfortable and convenient. - Journeys concentrated into several peak periods during the day. - Generally unfamiliar with the surface access system and transport options. - Likely to be carrying heavy luggage. - May be anxious, tired or stressed. - Complex flows, but will generally need to access terminal buildings. - Business passengers may travel more regularly than leisure passengers, place a higher value on the time of their journey than the cost, and are less likely to be carrying luggage than leisure passengers. - Non-resident and inbound passengers are unlikely to have access to a private car for their journey, and are more likely to be travelling from a hotel or friend/relative's house. - Resident and outbound passengers are likely to be travelling from home and have access to a private car. Trip origins/ends spread throughout the catchment area, with a relatively small share of trips to/from downtown regions.
Employees	- Can account for up to one third of total surface access journeys - Frequent journeys by a relatively small number of people - Very high private car use (and subsequently low-level of public transport usage) due to dispersed nature of trip origins, working hours lying outside the times of public transport operation, and subsidised or free car parking. - Work destination dispersed across the airport site, which can make public transport inconvenient.
Visitors	- 'Well-wishers' and 'Meeter-greeters' accompanying passengers to/from the airport, especially for international/leisure routes. - Generates extra vehicle traffic, which has increased environmental impact. - Visitors to airport catering and retail facilities
Cargo, supply, delivery and other commercial vehicles	- Cargo and airmail higher at major cargo hubs. - Various vehicles needed to supply and deliver catering and retail outlets in the terminal building.

Sources: Ashford et al. 2013; BIA, 2006; Coogan et al. 2008; de Neufville and Odoni, 2003; DfT, 2007; Dresner, 2006; Gosling, 2008; Humphreys and Ison, 2005; Humphreys et al, 2005; Ison et al. 2007; Ison et al. 2008; Leigh Fisher Associates et al. 2002; LeighFisher et al. 2010; Mandle et al. 2002; Marsden et al. 2006; Pels et al. 2003, Ricard, 2012.

Passengers, then, generally represent the majority of surface access journeys. At Birmingham International Airport, passengers account for between 75-80% of all trips (BIA, 2006). Unlike other airport users passengers are on the first or last segment of a relatively long distance multimodal trip (Leigh Fisher Associates et al., 2002). Passengers typically only need to access a few key buildings at the airport, such as the departure hall, but unlike other airport users may be tired, anxious and/or unfamiliar with local transport arrangements (Coogan et al., 2008). Moreover, passenger journeys are not spread uniformly throughout the day, but instead tend to be concentrated in several peak periods. These peaks generally reflect prevailing airline schedules arranged around the 8 hour working day (Ashford et al., 2013). It is estimated that larger airports can receive 4,000 vehicles per hour during peak times, which can lead to severe problems of congestion (de Neufville and Odoni, 2003).

Congestion problems are likely to be worse when there is a large share of passengers being dropped-off/picked-up at the airport. A study at Leeds-Bradford Airport, UK in 2004-05 found that nearly half of all passengers (49.0%) were dropped-off/picked-up by friends or relatives (Marsden et al., 2006). These journeys are identified as having a particularly disproportionate negative environmental impact as two extra vehicle trips are generated to and from the airport (one return trip to drop passengers off and another to collect them on their return). At Heathrow Airport it is estimated that 70% of CO_2 emissions from surface access traffic are from drop-off/pick-up (BAA Heathrow, 2008).

In some cases a passenger may be accompanied by a number of different ‘meeter-greeters’ or people seeing them off, especially if they are going away or have been away for some time. In some cultures it may also be considered courteous to accompany friends or relatives in this way. Together, this can generate significant additional traffic. Shapiro et al. (1996) calculated the average number of vehicle trips per passenger for different road-based modes to highlight this problem. Drop-off/pick-up journeys were found to generate the most trips (1.29 vehicle trips/passenger), followed by taxi (1.09 vehicle trips/passenger) and car parking (0.74 vehicle trips/passenger). In contrast, scheduled buses were found to generate the fewest vehicle trips (0.10 vehicle trips/passenger), which reflects the higher occupancy levels on buses compared with private vehicles.

In terms of the factors that govern mode choice, considering the time and financial costs associated with being late or missing a flight, passengers are generally highly time sensitive and require a surface access mode that is affordable, efficient and reliable (Dft, 2007). Overall, Ashford et al. (2013) posit that passenger mode choice is a function of perceptions regarding the relative cost, comfort and convenience of different modes. This is supported by research such as Psaraki and Abacoumkin (2002), who developed a model to forecast passenger mode share at the relocated Athens airport. They found that travel time and cost were the key factors influencing mode choice. Similar findings are reported by studies by Pels et al. (2003), Tam et al. (2010), and Chang-Jou et al. (2011).

Passengers generally favour using cars because of the perceived comfort, availability, flexibility, reliability, improved personal safety and security, low-marginal costs, ease of transporting heavy luggage and the short door-to-door journey times they provide (Kazda and Caves, 2008; Humphreys and Ison, 2005). For similar reasons taxi use is also generally higher for passengers than other airport users (de Neufville and Odoni, 2003).

A UK study of passenger perceptions of different surface access modes published in 1993 discovered that the highest importance was placed on ease of baggage handling, the convenience of transfer to the check-in area, and journey time (Ashford et al., 1993). In contrast, cost considerations relating to total journey cost and car parking expenses were considered less important in comparison. Table 2.2 shows the relative importance passengers at Heathrow Airport assigned to different factors affecting their mode choice.

Table 2.2 Ranked importance of different factors in passenger mode choice

Rank	Attribute
1	Ease of baggage handling
2	Convenience of transfer to check-in
3	Expected access journey time
4	Comfort of mode
5	Parking space availability
6	Convenience of interchanges where more than one vehicle or mode is used
7	Actual journey time
8	Delay and congestion
9	Cost of mode
10	Overall opinion of access mode
11	Access information
12	Parking cost

Source: Ashford et al. 1993

The importance of the ease of transporting luggage as a factor determining mode choice is supported in the literature (Kazda and Caves, 2008; Coogan et al., 2008) and it is recognised as being a key factor deterring passengers from using public transport. As Coogan et al. (2008) explain;

> *"A major impediment to the choice of a public mode for ground access is a lack of baggage accommodation"*
>
> Coogan et al. 2008, p107

This is generally presumed to be more of an issue for leisure passengers, who are more likely to be travelling with heavy or outsized luggage (such as skis or golf clubs) than business passengers. In a survey conducted at Baltimore-Washington International Airport in the US, Dresner (2006) confirmed the belief that leisure passengers were more likely to be carrying luggage than business passengers, reflecting the fact that leisure passengers will generally be staying away for longer than business passengers (Leigh Fisher et al., 2002). Accommodating leisure passengers and their luggage is subsequently identified as a major challenge for airports with regards to provision of suitable surface access by public transport.

> *"The non-business traveller emerges as a major problem for baggage handling.*"
>
> Coogan et al. 2008, p108

Business and leisure passengers may also vary in terms of their relative sensitivity to time and cost factors. In a study of surface access mode choice in the San Francisco Bay Area region, Pels et al. (2003) found that business passengers place a higher value on their time than leisure passengers but a lower value on the cost of their trip. Similarly, Hess and Polak (2006) developed a joint model of airport, airline and mode choice in the same region and found that business passengers were prepared to pay more for a shorter access time to the airport than leisure passengers. This intuitively makes sense, as travel costs for business passengers are often covered by their employer or another external provider (Coogan et al., 2008).

Business passengers also tend to fly more often than leisure passengers. In the study at Baltimore-Washington Airport in the US, Dresner (2006) found that 22% of business passengers had flown from the airport more than 10 times in the past year, compared with fewer than 5% of leisure passengers. As they travel more regularly, business passengers may form established patterns of behaviour based on past experiences of negotiating the most efficient route to/from and through particular airports (Leigh Fisher et al., 2002). In contrast, leisure passengers may have little knowledge of where to access travel information relevant for their journey (especially if they are a first-time visitor to the region), and may have comparatively little experience of travelling from the airport to call upon. As a result, the relative split between leisure and business passengers at an airport can have an important impact on overall mode share (LeighFisher et al., 2010). Mandle et al. (2002) therefore suggest that airports with a larger share of business passengers are likely to attract a greater share of rail users than airports serving leisure passengers.

Whether the passenger is a resident of the region in which the airport is located is also important, as resident passengers are more likely to be travelling from home and have access to a car for their journey (Leigh Fisher et al., 2002; Coogan et al., 2008). Visitors to a region, on the other hand, will be making the return leg of their trip back to the airport and will generally not have access to a private car for their journey (Coogan et al., 2008). These passengers will often stay in a hotel or with friends or relatives and will generally use taxis, be dropped-off, or take public transport (ibid, 2008). Airports with a high share of resident passengers may therefore expect to obtain a lower share of public transport journeys compared with airports with high visitor numbers. For example, in their ASAS, Manchester Airport recognised that increasing public transport mode share is difficult because a large proportion of their customers are outbound (i.e. resident) passengers (Manchester Airport, 2007).

2.3.2 Employees

Employee trip characteristics vary considerably from passenger journeys. These people are employed on the airport site by companies including the airport operator, airlines, airport tenant companies, cargo and maintenance firms, and government agencies such as customs and immigration staff (LeighFisher et al., 2010). Unlike passenger journeys, a relatively small number of employees (in proportion to total passenger numbers) undertake a large number of regular trips to and from the airport. Manchester Airport, for example, has around 19,000 staff employed on site (Manchester Airports Group, 2012), compared with around 18 million annual passengers (CAA, 2012).

As de Neufville and Odoni (2003) note, it is important not to overlook employee travel because of the frequency with which these trips are made. It is estimated that a full time employee makes in the region of 500 single trips to and from the airport per year (Humphreys and Ison, 2005). Employee trips can account for one-third of access journeys at an airport, but can be much higher if the airport acts as the headquarters for a large aviation company or as the base for engineering or maintenance facilities (Humphreys and Ison, 2005; Graham, 2008).

Generally, employee car use is even higher than for passengers (Humphreys et al., 2005). Public transport networks are often not suited to employee travel requirements. As noted by Ricard (2012), regional public transport systems are designed to accommodate ‘traditional’ weekday work start and end times. Given the 24 hour nature of airports, employees will often need to travel at antisocial times of the day and night in periods that are typically poorly served by public transport (Humphreys and Ison, 2005).

The public transportation system may also not provide the necessary geographic coverage to serve employees’ trip origins. Public transport services typically converge in downtown areas (Ricard, 2012) whereas employees will generally be travelling to/from predominately residential areas (Humphreys et al., 2005). Even where employees live close to the airport they may still be unwilling to use public transport to access the airport. Around 25,000 people are employed at Gatwick Airport, with one third living in the nearby towns of Horley (about 1 mile/1.6 km away) and Crawley (2 miles/3.2 km away). Despite the relatively short travel distances, only 11% of these employees use public transport to travel to and from work (BAA Gatwick, 2007). For employees who do not work in areas close to the passenger terminal, public transport networks may also be inconvenient for them as routes and stops are generally arranged for the convenience of passengers alone (Ricard, 2012).

Airport employees often work to set shift patterns. At Heathrow Airport roughly 75% of employees work shifts (Humphreys and Ison, 2002). This can also add to problems of traffic congestion if the changeover of shift times coincides with peak periods of passenger traffic (Humphreys et al., 2005).

Unlike passengers, employees typically receive free or subsidised car parking. Parking permits are usually sold by the airport operator to the airports tenant companies who then distribute them among their own staff. Companies often choose not to pass these costs on to their employees for reasons of staff recruitment and retention (Humphreys and Ison, 2005). Subsidised or free parking is often included in collective bargaining agreements with employees as part of their benefits package (Ricard, 2012). However, airport operators may be keen to limit the supply of employee parking given that passenger spaces generate 7-10 times more annual revenue than the same space devoted to employee use (Humphreys and Ison, 2005).

Consequently, airports are becoming increasingly keen to encourage employees to reduce their private car use and switch to more sustainable options such as carpooling, or ideally, public transport (Ricard, 2012). Changing staff travel behaviour can be a difficult proposition, however, as the majority of employees are often not directly employed by the airport operator. It is estimated that as many as 90% of airport staff are employed by third party tenant companies. This can make it difficult for airports to exercise much control over their behaviour (Ison et al., 2008). It is also important that managers exercise caution when dealing with employee issues, especially in relation to car parking, as it is reportedly one of the most emotive subjects there is in employee relations issues (Ison et al., 2007). As a result, airport operators have tended to accommodate employee parking demands rather than attempt to initiate modal shift (Ricondo and Associates et al., 2010).

2.3.3 Visitors

Visitors to airports generally accompany departing passengers (well-wishers) and arriving passengers (meeter-greeters), although a small number may also be attending meetings with companies on the airport site. Airports with a larger share of passengers travelling overseas for leisure reasons are likely to experience a greater share of visitors than airports possessing a more business focus (LeighFisher et al., 2010). Other visitors to airports may include people taking advantage of airport retail and catering facilities, or aviation enthusiasts who come to watch the aircraft. At some airports this can represent a significant number of people. The Runway Visitor Park at Manchester Airport for example attracts around 300,000 visitors per year and is one of the most visited tourist attractions in the north-west of England (Manchester Confidential, 2011).

2.3.4 Cargo, supply, delivery and other commercial vehicles

This group of airport users need to access the airport to transport air cargo (including airmail) and to supply/service the airport (de Neufville and Odoni, 2003). The volume of air cargo trucks and delivery vans, as well as the times they operate, will vary between airports, but will inevitably be higher if the airport acts as a major cargo hub. East Midlands airport, for example, is a major base for cargo companies including DHL, UPS and the Royal Mail. Owing to the 24 hour nature of just-in-time logistics, heavy-goods vehicles are using the local road network at antisocial hours. Other cargo-related trips may be generated by vehicles replenishing stock in airport retail or food outlets. The increased utilisation of revenue generating space at airports, with the development of business parks, hotels, freight facilities and other airport related industries, has inevitably generated additional traffic from cargo, supply and delivery vehicles (Humphreys and Francis, 2002; Graham and Guyer, 2000). To date there has been comparatively little research into supply/delivery vehicle trips, and there is little data available to forecast future changes in this area (LeighFisher et al., 2010).

2.4 The geographic distribution of surface access traffic

The geographic distribution of surface access traffic is an important consideration for airport managers as different surface access transport options are more or less suited to certain regions in the airport's catchment area (Leigh Fisher Associates et al., 2002). The distribution of surface access traffic is the product of various factors such as the airport's proximity to competing airports, the relative services and air fares offered by the airport and competing airports, the regional transport network and the physical geography of the area (Coogan et al., 2008).

Within the catchment area there exist various geographical 'submarkets' which are more or less suited to different transport modes.

- *A densely clustered market*- typically downtown regions with a high concentration of trip origins/ends, which may be suitable for fixed route public transport services such as rail.
- *A 'middle' market*- area with less concentrated trip origin/ends which may struggle to support traditional fixed route services, but shared door-to-door services may be possible.
- *An exurban market*- highly dispersed trip origins/ends where support for high occupancy modes or fixed route public transport services is largely unfeasible.

Source: Adapted from Mandle et al. 2002; Coogan et al. 2008

Most UK airports serve a particular city (for example Manchester Airport) or are located so as to serve a number of smaller urban areas (for example, East Midlands

Airport which serves the cities of Derby, Leicester and Nottingham and their immediate hinterland). Airports with a relatively high proportion of passengers originating from or travelling to these downtown regions are likely to have a higher share of public transport journeys, as the higher passenger numbers can support more frequent services (Coogan et al., 2008). Where the airport is located relatively close to the city or downtown region that it serves the share of taxi journeys is generally higher than a more remotely located airport. For a more distant airport, the share of public transport journeys is likely to be higher than for a taxi due to the comparatively shorter journey time and lower fare offered by the former (ibid, 2008).

However, at most airports the share of passengers travelling to/from city centre or downtown regions is relatively small. LeighFisher et al. (2010) suggest that generally fewer than 30% of trips begin/end in downtown areas, whereas Mandle et al. (2002) suggest that this figure is closer to 10-15% of trips. A survey conducted in 1996 at Boston's Logan Airport revealed that only 8% of passengers started or intended to end their journey in the city centre (Ashford et al., 1997). As noted in Section 2.3.2, employees are also more likely to be travelling to/from residential areas than downtown ones (Humphreys et al., 2005).

2.5 The commercial needs of airport operators

As stated by de Neufville and Odoni (2003), there are clear economic incentives for airports to try and attract private vehicle access as car parking revenues form a major part of the airport business. At some US airports, parking revenues can account for as much as 26% of total revenue (Jacobs Consultancy et al., 2009). This can create tension between achieving environmental goals related to reducing private vehicle journeys on the one hand, and commercial needs related to airport parking on the other.

To compound the problem, managers must also balance other tensions and trade-offs related to competing demand for car parking space and maintaining cordial employee relations. There are competing pressures to provide parking spaces for passengers and employees. Demand for passenger spaces may be seasonal and highest around traditional holiday periods (Ison et al., 2008). Demand for employee parking space is also generally high because of the high private car use exhibited by this group (Humphreys et al., 2005). In addition, expansion of airport terminal operations (especially retail) may place extra pressure on airport parking facilities (Freathy and O'Connell, 1998; Ison et al., 2007).

Car parking is also an important airport competition issue. Overly expensive, restricted or otherwise poor parking provision can place an airport at a competitive disadvantage when compared to its rivals (Ison et al., 2008). Certainly, the multitude of websites offering on-line airport parking always emphasise price comparisons. Furthermore, if passengers choose to be dropped off at the airport rather than incur parking costs, airport managers may have to contend with the dual problem of increased congestion on airport roads and terminal kerb sides, as well as reduced parking revenues. In a study conducted at 15 US airports, it was found that constrained parking conditions led to increased use of passenger drop-off/pick-up at a higher rate than increased use of public transport (Ricondo and Associates et al., 2010). Consequently, constraining the supply of car parking may in fact increase problems of congestion and emission rather than improving them.

2.6 The effect of external market conditions

One of the key difficulties associated with surface access is that in most cases airport operators can exert only a limited influence over the individual stakeholders and operators involved. As stated by Humphreys and Ison (2003), the commercialisation and privatisation of airport infrastructure and transport services makes coordination of surface access planning difficult since these organisations each operate for the benefit of their own shareholders. To an extent, airports are dependent on something that they may have little direct control over (Ashford et al., 2013). It is therefore important that airports are flexible with regards to surface access planning and provision as fluctuations in external market conditions can have important knock-on impacts for surface access.

An example of the effect changes in external market conditions can have on surface access relates to changes brought about by the liberalisation of the European Aviation market, as addressed in Section 2.2, and the subsequent growth of the low-cost airline sector. These low-cost carriers eschewed existing airline business models by offering short haul point-to-point services (as opposed to hub and spoke networks) and imposing aggressive cost management procedures that aim to reduce expenditure whilst increasing output and productivity (Dobruszkes, 2006; Pitfield, 2008). The lower air fares offered by airlines such as Ryanair and easyJet provided clear cost incentives for travellers to fly to and from certain (often secondary or regional) airports, many of which are some distance away from the city or destination they are promoted as serving, as noted by Pitfield (2007). Subsequently, there was an increase in the ability of passengers to discriminate on a geographic level between competing fares and service levels (and, correspondingly, airports) for their travel requirements (Fuellhart, 2007). In essence, many passengers have become increasingly willing to compromise longer journey times to more distant airports in return for lower air fares (Barrett, 2000). As Lian and Rønnevik (2011) note;

> *"Travellers are willing to spend several hours extra driving to a larger airport in order to take advantage of lower fares and more convenient airline services."*

Lian and Rønnevik, 2011, p85

This form of airport 'substitution' (Suzuki and Audino, 2003) has had clear environmental implications, as not only are passengers travelling further but the majority will do so by private car (Dennis, 2004). Before low-cost operations began at Stansted Airport there was little incentive for passengers (especially those living in Greater London) to choose Stansted as the range of services and fares was worse than those on offer at other major London airports and the surface access journey took longer. The introduction of low-cost services, however, saw average air fares drop to half of those at Heathrow, and subsequently *"people* [were] *willing to drive past their nearest airport to fly from Stansted"* (ibid, 2004, p7). At Hannover Airport in Germany, a study found that passengers who flew on the low-cost carrier Hapag Lloyd Express originated from more distant regions compared with other passengers (Pantazis and Liefner, 2006).

The development of the low-cost model has also been characterised by fluctuating traffic levels at airports. Passenger numbers at Frankfurt Hahn Airport, for example, grew from 450,000 in 2001 to around 1.5 million a year later after Ryanair commenced operations at the airport (Gillen and Lall, 2004). However, low-cost airlines have also been quick to reduce services at an airport if financial terms become unfavourable to them or if routes underperform financially. This shift in the traditional airport–airline relationship and the increased volatility of airline traffic can make surface access planning challenging, as it increases the risks associated with investment in facilities and infrastructure (Humphreys et al., 2006). Essentially, there is an inherent incompatibility between the need for airports to invest in key surface access infrastructure, such as roads, rail access or car parks, which may be expensive and take years to complete, and fluctuating traffic levels which can change dramatically and at very short notice (de Neufville, 2008).

2.7 Surface access management strategies

In light of the issues identified in Sections 2.2-2.6, the chapter now turns towards the strategic options that are available to airport managers. These are addressed in relation to existing and proposed strategies at airports in the UK and overseas. Given the need to reduce the share of private vehicle trips (see Section 2.2), an overarching theme of contemporary surface access strategies relates to achieving behavioural change among airport users to get them to use more sustainable modes (Humphreys et al., 2005). For example, Manchester Airport's ASAS states:

> *"Our ability to influence the travel behaviour of both passengers and employees is critical to the success of our Ground Transport Plan".*
>
> Manchester Airport, 2007, p34

These strategies incorporate a range of measures such as operational interventions, market based incentives, or physical improvements. Strategies will generally be applied in conjunction with other measures, but may be designed to operate on different time scales (either short or long term). A summary of various short and long term strategies is provided in Table 2.3.

Table 2.3 Summary of surface access strategy options for airport managers

Timescale	**Strategy**
Short term	Data collection and monitoring of targets for passengers and employees
	Capacity and revenue management of passenger car parking
	Introduction of drop-off/pick-up charges
	Employee travel plans, car sharing, travel cards and preferential car parking spaces for staff who car share
	Up to date and accessible travel information for passengers and clear on-site signs
	Ensuring an easy connection to the terminal building from public transport modesOther customer service benefits such as heated/air conditioned waiting areas and staffed ticked offices
Long term	Management of airport roads, reconfiguration of traffic lanes/queuing spaces
	Construction of high occupancy vehicle lanes
	Increasing rail access through provision of new services and key infrastructure
	Development of off-site check-in facilities
	Development of public transport interchanges
	Development of off-site surface transportation facilities

Sources: de Neufille and Odoni, 2003; Jacobs Consultancy et al. 2009; LeighFisher et al. 2010; Ison et al. 2007; Coogan et al. 2008; BAA Heathrow, 2009; BIA, 2006; Sharp, 2006; Manchester Airport, 2007; Ashford et al. 2013; Humphreys and Ison, 2003; Kazda and Caves, 2008; Leigh Fisher Associates et al. 2000.

2.7.1 Short term strategies

Shorter term strategies for managing surface access may relate to operational measures or physical improvements. As outlined in the directives for ASAS, UK airports are now responsible for setting targets for reducing the share of private vehicle journeys (DETR, 1998). It is therefore important that airports conduct regular data collection exercises to obtain relevant information on surface access use and passenger behaviour. For passenger surface access information airports in the UK largely rely on information provided by the Civil Aviation Authority (CAA) which is gathered as part of their annual passenger surveys (see CAA, 2012 for an example). The surveys provide airports with a wide range of surface access information relating to mode choice, trip purpose, type of journey, origin, destination, and group size, although they do not account for journey cost. While the four largest airports in the UK (Heathrow, Gatwick, Stansted and Manchester) are surveyed every year, smaller airports are surveyed less regularly. For example, passengers at Birmingham Airport were only surveyed four times between 1999 and 2011. In contrast, collection of employee surface access data is generally conducted 'in-house'. This led Humphreys and Ison (2003) to question the representativeness and robustness of these surveys, especially given their relatively low response rates.

Provision of adequate car parking facilities is also inevitably an important consideration for airports given the high number of private vehicles. Major airports typically provide between 200–1,200 spaces per million annual passengers and 250–500 parking spaces per 1,000 employees (de Neufville and Odoni, 2003). The area required for car parking can be extremely large, for example, Stansted Airport has the largest surface car park in Europe (BAA Stansted, 2008). This incurs additional costs for the airport relating to maintenance and security.

As described in Section 2.5, passenger car parking is an important revenue stream for airports. Management of passenger spaces is typically achieved through a price mechanism and the careful allocation of spaces between the major types of parking: spaces to pick up and drop off passengers, short-stay parking, long-stay parking and rental car parking (de Neufille and Odoni, 2003). In addition, so-called 'value added products' such as valet parking or car servicing may be offered to passengers, in the hope of enhancing customer service and generating additional revenue (ibid, 2003). Increasingly, airports are also adopting sophisticated yield and revenue management practices similar to those used by airlines and other tourism operators, that vary the price of individual spaces according to demand and the time at which the reservation was made to extract the maximium amount of revenue from each (Jacobs Consultancy et al., 2009).

To reduce congestion at drop-off/pick-up areas a number of UK airports, including Luton, East Midlands and Edinburgh, have introduced charges for passengers being dropped off/picked up at the airport (LeighFisher et al., 2010). Unsurprisingly, these charges have proved unpopular with passengers. After the introduction of a drop-off charge at East Midlands Airport in 2010 the local newspaper ran an article with the headline "*Pay as you Go: Is airport's new drop-off charge a move to combat congestion- or a money making scheme?"* (*Leicester Mercury*, 15/7/10). UK airport operators may be reluctant to implement road user charges, such as the one currently in operation at Dallas Fort Worth Airport in the United States, for reasons of unfavourable publicity.With respect to employee parking, airports have traditionally relied more on ‘softer’ incentive measures to encourage the use of more sustainable modes. These incentives may include developing staff travel plans, car-sharing schemes and implementing other incentive measures such as travel cards or preferential car-parking spaces for employees who car share (BAA Heathrow, 2009; BIA, 2006). Such policies are attractive to airport managers as they are less likely to risk straining employee relations (Ison et al., 2007).

Other short term strategies may include better information provision for airport users. For passengers especially, a lack of information can influence mode choice decisions, especially in cases where users may be unaware of the services available to them (Coogan et al., 2008). Provision of accurate, up to date travel information in different formats and multiple languages is therefore important and may include timetables, real-time travel information and multilingual on-site signs (BIA, 2006). Appropriate, accurate and accessible information is especially important for passengers who may be unfamiliar with the airport and the surrounding public transport network. Advances in web-based media and the widespread adoption of the internet in recent years also have seen the development of freely available web-based services that allow passengers to plan their trip comprehensively to and from the airport. Typically, these websites will convey information on available transport options, their relative costs and duration as well as timetables, live journey updates, and other useful information (Coogan et al., 2008). Much of this information can now also be accessed on the move via smartphones or tablet PCs.

Various customer service improvements can also be made in the short term to encourage the use of public transport. As Ashford et al (1993) noted (see Section 2.3.1), the ease with which passengers can transfer to the terminal is a key factor in explaining mode choice. These passengers may be unfamiliar with the airport and encumbered with heavy luggage, and as such it is important that the connection to the airport terminal involves only a short walk and no changes of level (Coogan et al., 2008). In contrast, a long walk or trip on a shuttle bus to access the terminal is likely to be seen as less attractive (Sharp, 2006). Other customer service improvements may include heated/air-conditioned waiting areas adjacent to public transport connections with food kiosks and shops. Staffed transportation information and ticket desks can also help to increase the attractiveness of public transport services to passengers and lower fear of crime and anti-social behaviour (Coogan et al., 2008).

2.7.2 Long term strategies

Longer term strategies typically involve physical improvements to existing infrastructure or construction of new projects, as well as broader objectives such as long term behavioural change initiatives.

Given the high volumes of surface access traffic experienced at larger airports, maintaining adequate road capacity is inevitably an important consideration for airport managers. Leigh Fisher et al. (2010) identify four types of surface access roads; access roads, kerb side roads, circulation roads, and service roads. At larger airports access roads will typically need to consist of several lanes of traffic in each direction. Other improvements to access roads can include construction of new traffic lanes or reconfiguring existing roads, for example by reducing the width of existing lanes to create new ones (Leigh Fisher et al., 2010). Other improvements may involve strategies for minimising the potential for congestion such as by increasing queuing space (ibid, 2010).

Road configuration also plays an important role in bus and coach access. One way in which airports have attempted to increase the attractiveness of these services is to provide dedicated high occupancy vehicle (HOV) lanes (Coogan et al., 2008). These are already common in the US but are increasingly being used in the UK; a number of airports refer to existing or planned HOV lanes in their ASAS (for example, Manchester Airport, 2007; BAA Heathrow 2009). In some instances these may dramatically increase the speed and reliability of services to the airport, although this does not necessarily guarantee high ridership (Coogan et al., 2008).

In the last twenty years there has also been a great deal of activity at larger airports to increase rail access (Ashford et al., 2013). Factors that favour competitive rail services include sufficiently high passenger numbers (to cover costs and allow for a more frequent service), the existence of local rail services (to minimise construction costs), easy connections to a wide metropolitan transit system and current difficulty in accessing the airport by private car (Kazda and Caves, 2008). In addition, rail links should connect to downtown, regional and national markets in order to serve dispersed trip origins (Leigh Fisher Associates et al., 2000). A rail link can help to increase the size of an airport's catchment area (Ashford et al., 2013), improve an airport's prestige (Sharp, 2006) and generate valuable revenue. In 2008, for example, the Heathrow Express rail link generated £86m for the airport's operator BAA (BAA, 2009). Different rail services are better suited to some airport users than others. Dedicated express rail services such as the Heathrow Express are generally frequented more by business passengers due to the faster speed and relatively high cost of these services (Coogan et al., 2008). Local rail and commuter services on the other hand may be more suited to employees as these services are generally less expensive and better at serving dispersed trip origins (Sharp, 2006).

Rail access to airports inevitably requires provision of terminals, waiting areas, ticketing facilities and other related infrastructure, which can be both expensive and take a long time to implement (Coogan et al., 2008). As noted by Humphreys and Ison (2003), among others, rail access is therefore only economically feasible for larger airports with passenger numbers high enough to support regular services. An example of an on-going rail investment project in the UK is the extension of the Manchester Metro link light rail network to Manchester Airport, which is expected to open in 2016 (Manchester Airport, 2007). There are also longer term plans to possibly integrate Heathrow Airport and Manchester Airport into the route of the proposed new HS2 High Speed rail network (ARUP, 2012).

As described in Section 2.3.1, carrying luggage is identified as an important factor in passenger mode choice (for example, see Ashford et al., 1993; Kazda and Caves, 2008; Coogan et al., 2008). As a result, there have been some attempts to mitigate this problem by developing facilities whereby passengers can check in their luggage at off-site locations, such as major railway stations. The most notable example of this in the UK was the downtown check-in facility at Paddington railway station for passengers travelling to Heathrow, which was opened in 1999. However, the facility did not receive sufficient patronage to make it economically viable and it was subsequently closed in 2004 (Coogan et al, 2008). There have been few examples of similar check-in facilities in recent years, due in part to security concerns following the 2001 terrorist attacks and the increasing availability of online ticketing and check-in procedures (Ashford et al., 2013).

Some larger airports have also sought to develop into public transport interchanges. ‘The Station’, opened at Manchester Airport in 2004, is an example of such a development. These act as hub points by bringing together public transport networks at the airport and providing a single facility where passengers can change easily between different modes (Humphreys and Ison, 2003). The rationale behind developing airports as transport hubs is to increase the critical mass of people accessing the airport in order to support regular services, although it could be argued that by increasing overall trips to the airport such strategies may become counterproductive (ibid, 2003).

Land shortages or existing problems of traffic congestion have also led some airports to develop dedicated off-site surface transport facilities away from the airport, where passengers can receive their tickets, check in their baggage and travel to the airport in dedicated high occupancy vehicles (Sharp, 2006). While such schemes are not common in the UK they have proved successful elsewhere, particularly at airports in North-America (MarketSense Consulting LLC et al., 2010).

Given the high costs and lengthy time scales associated with large scale construction projects, combined with the current economic downturn and uncertainty over future passenger levels, airports may be increasingly reluctant to invest in projects such as off-site transport facilities. de Neufville (2008) states that as a result there has been a paradigm shift in airport design and planning towards providing lower cost, more flexible facilities in recent years.

Regardless of the type or timescale of the measures being used, it is widely acknowledged that strategies stand the greatest chance of success when they are targeted at specific groups or sub-groups of airport users, as opposed to a adopting a ‘one size fits all’ approach. As Leigh Fisher Associates et al. (2002) explain;

> *"There is no single market for ground access services to airports: there are a series of submarkets, or market segments, that each have distinct and documentable characteristics. Very often, it is necessary to create separate services for separate market segments; usually the form of marketing, pricing and promotion of services will vary by the market segment that is being sought."*
>
> Leigh Fisher Associates et al. 2002, p51

Typically, these 'submarkets' or 'segments' will be defined according to predetermined characteristics such trip purpose or country of residence. For example, Leigh Fisher Associates et al. (2002) classify passengers as belonging to one of four distinct segments; resident business, resident non-business, non-resident business, and non-resident non-business. While in this case passengers can be assigned to one of the four categories in advance, recent travel behaviour research has shown a growing awareness of the benefits of adopting *post hoc* segmentation techniques, whereby people are grouped according to a set of revealed characteristics or shared attitudes (for example, see Anable, 2005). As noted by Stradling et al. (2000), among others, policies are likely to stand the greatest chance of success when they are targeted at specific groups or market segments. However, there are few examples of this more advanced form of segmentation in the surface access literature.

2.8 Conclusions

Chapter 2 has presented a review of the surface access literature in order to address the first research objective and "identity key surface access issues". It is clear that surface access is a complex and demanding airport management issue. The continued dominance of private vehicle journeys in the modal share has led to severe problems of congestion at airports, with associated negative environmental impacts relating to increased vehicle emissions. There is subsequently a need for airports to develop strategies to reduce the share of private vehicles and increase public transport access. This is recognised in UK government policy, with airports required to form ATF and create ASAS for setting mode share targets. However, questions remain about the ability of ATF and ASAS to achieve long lasting reductions in private vehicle trips due to a lack of comparability between airports, the unsuitability of existing mode share targets, the inconsistent nature of the metrics used to measure the targets, and the lack of consequences for airports should they fail to meet them (Humphreys et al, 2005). Consequently, there is a need for research to be undertaken that can yield benefits for airport decision makers in terms of recommendations for reducing private vehicle trips.

The task facing surface access decision makers is clearly not an easy one. As Section 2.2 demonstrated, strategies must account for the contrasting and often mutually incompatible requirements and characteristics of different airport users who each place varying demands on the system. Issues posed by passengers are also very different from those for employees. While passengers represent challenges associated with customer service, revenue generation and airport competition, employees pose problems in terms of staff recruitment, retention and maintaining cordial employee relations. Satisfying the needs of both groups profitably and within a framework of carbon reduction requires different management approaches.

Further difficulty arises from the apparent conflict of interest that exists between environmental goals related to reducing private vehicle trips on the one hand, and commercial necessities relating to passenger car parking and airport competition on the other. Because of the commercially driven nature of modern airports these goals appear largely incompatible with one another and as such represent a significant barrier to reducing surface access's environmental impact.

The review of the literature has also highlighted a range of strategic options for airport decision makers (Section 2.7), including operational measures, market-based measures and physical improvements. While operational and market-based measures generally can be implemented in the short term, physical improvements generally operate on longer timescales. Given the large capital investments and time scales typically involved in planning and construction of new infrastructure, airport operators may be unwilling to invest heavily in long term, potentially risky projects, especially in the current economic climate.

Given the need for airports to reduce the share of private vehicle journeys and increase public transport access there has been increasing focus on the need to instigate behavioural change initiatives to facilitate modal shift (Humphreys et al., 2005). Intuitively, in order to change behaviour it is important that one must first examine and understand it. The lack of research explicitly examining the attitudinal and psychological determinants of surface access travel decisions is therefore significant, especially considering recent trends in UK government policy (for example, DfT, 2011b). By adopting a socio-psychological approach to examining surface access travel behaviour the thesis seeks to address this gap in the existing knowledge base and develop a new agenda for airport surface access research.

While the review of literature has helped to identify the key surface access issues there are a number of questions that remain. Namely, it is important to establish whether the nature and scale of surface access issues vary between airports, and whether certain issues are unique to particular airports. UK airports vary considerably in terms of their size, market position, ownership and geographical location, so intuitively it would seem likely that the nature and scale of surface access issues will also vary. Further questions relate to whether certain management strategies are generally more effective or preferable than others, as well as the likely directions of surface access policy in the future.

The following chapter seeks to address these research questions by analysing the responses to a series of semi-structured interviews that were conducted with key personnel responsible for surface access management at UK airports. The chapter forms a scoping study to help guide the research. Practitioners are a useful unit of analysis given their significant experience and in depth knowledge of the surface access problem and issues surrounding it. Ultimately, it is also these people who have the ability to form and influence future surface access policy, so their input and involvement is essential to the present research which seeks to yield impacts for decision makers.

Chapter 3

Scoping study: an airport management perspective

3.1 Introduction

Chapter 3 reports on the findings of a scoping study that seeks to gain an understanding of the “challenges, implications and future directions of surface access management (objective 2)”. In the previous chapter a synthesis of the literature helped to identify key surface access issues. This literature review demonstrated that there is a need for airports to reduce the share of private vehicle journeys and increase public transport use to and from airports to help alleviate problems of congestion and lower vehicle emissions. Within this there exist a number of issues such as the difficulties associated with accommodating the varying demands of airport users, balancing commercial pressures against environmental goals, accounting for the geographic spread of surface access trips and remaining flexible enough to absorb changes in external market conditions.

In addition, a number of important questions that could not be answered using the literature were identified. As a result, ten interviews were conducted with key personnel responsible for surface access management at UK airports. Practitioners are valuable units of analysis because they influence policy making and provide an easily accessible and in depth source of information. The key research questions that the interviews sought to address are:

"How does the nature and scale of surface access issues vary between UK airports, are some issues unique to particular airports (research question i)?"

"Are certain strategies considered to be more effective or preferred by airport managers than others (research question ii)?"

"What are the likely future directions of surface access policy (research question iii)?"

In the following section, Section 3.2, a description of the methods employed for conducting the interviews is provided. This includes a description of the interview format and structure, the sampling frame, and the methods used for conducting and analysing them. The interview findings are then discussed in Section 3.3. A summary of the principal themes is then provided at the end of the chapter in Section 3.4.

3.2 Method for conducting the interviews

3.2.1 Interview format and structure

A semi-structured interview format was selected for the interviews. A semi-structured approach was favoured because as well as enabling information to be collected around a set of predetermined topics, it also affords the interviewer the flexibility to further address themes considered to be of particular importance, or even explore topics that were not included in the original interview schedule (Longhurst, 2010; Gibson and Brown, 2009).

Interview questions were based around four broad themes; airport users, commercial and environmental issues, external market conditions and policy options. A list of the interview questions is provided in Table 3.1. The 'inverted-funnel' approach was adopted, whereby general questions are arranged at the start of the interview to engender participant interest and help them ‘warm-up’, while more complex questions are ordered later in the interview (Frankfort-Nachimias and Nachimias, 1996). While general questions were always asked first, the order of the other questions varied between interviews. In some cases not all the questions were asked, either due to time constraints or because the participant had covered them as part of a previous answer. At the end of the interview participants were thanked for their time, assured that their responses were confidential, and were asked if they had any further questions or if there was anything that they would like to add. The contents and conduct of the interviews adhered to the ethical code of practice relating to investigations involving human participants, as outlined by Loughborough University (available at: www.lboro.ac.uk/admin/committees/ethical/cophp.thm).

3.2.2 Summary of the interview sample

Key personnel responsible for surface access management at UK airports were identified using a combination of online searches and snowball sampling, whereby respondents that had already been identified helped to recruit additional subjects by suggesting further possible candidates from their own contacts and acquaintances. Subsequently, managers were contacted at the 25 busiest airports in the UK either by e-mail or telephone and invited to conduct an interview. Together the 25 airports accounted for 98.6% of UK passengers in 2009, and were thought to represent airports where surface access issues were likely be more acute and, subsequently,

Table 3.1 Interview questions

Theme	Question
Introductory/ General	Could you briefly outline your job title and what the role entails? What do you feel are the issues currently facing the airport sector in the UK? What are the current surface access issues at UK airports? Could you describe the surface access issues currently facing your airport?
Airport users	Could you tell me about the various passenger groups who use your airport? Could you describe the impacts of 'drop-off/pick-up' passengers at your airport? What kind of issues do employees pose? Who are the main users of public transport at your airport?
Commercial and environmental issues	Surface access to airports has traditionally been dominated by private car trips. Why do you think that this is the case? What do you think are the main environmental impacts of surface access? What are the issues associated with airport parking management? What are the issues associated with providing public transport at your airport? Where do you think there is greatest scope for improving the environmental impacts of surface access in the future?
External market conditions	What are the surface access implications of the growth of low-cost carriers? How has the growth of low-cost carriers affected surface access at your airport? From a planning perspective, do passengers travelling on low-cost carriers pose any particular surface access challenges? How involved are airlines in surface access planning decisions at your airport?
Policy options	What surface access data do you collect at the airport? What are the barriers to surface access planning? Could you describe the various stakeholders involved in surface access at your airport- what issues do they pose? Would you like to elaborate on any recent surface access initiative at your airport? Who is responsible for improving the environmental impacts of surface access? What will be the key surface access challenges over the next 10 years?

where managers would likely have the greatest need to increase environmentally sustainable surface access travel. Ten personnel responded positively to the interview request, and semi-structured interviews were held with them. Each participant had significant experience of managing surface access issues. Interviewees were the designated employee responsible for surface access at the airport. This person was either a surface access manager or was responsible for surface access issues as part of a wider job remit (for example, as an environmental manager).

In some cases it was found that managers were responsible for surface access issues at other airports in addition to the one where they were normally based. For example, a manager based at a large airport may also be responsible for one or more of the airport operator's other 'sister' airports. Consequently, the 10 interviews accounted for 14 airports in total.

The 14 study airports were differentiated in terms of size using Humphreys and Ison's (2005) classification system, which groups airports according to their annual terminal passenger numbers (>10 million passengers = large, 2-10 million passengers = medium, <2 million passengers = small). Using this classification system the 14 airports represented in the interviews constitute 3 large airports, 7 medium sized airports and 4 small airports. As well as size, the airports varied in terms of their location, their accessibility (in terms of available transport modes) and the markets they serve. Table 3.2 classifies the 14 airports in terms of their size and transport modes.

Table 3.2 Airports in the study

Airport	Size	Annual Pax	Local Bus	Coach	Heavy rail	Metro or underground
1	Large	>10m	✓	✓	✓	✓
2	Large	>10m	✓	✓	✓	
3	Large	>10m	✓	✓	✓	
4	Medium	2-10m	✓	✓	✓	
5	Medium	2-10m	✓			
6	Medium	2-10m	✓			
7	Medium	2-10m	✓	✓		
8	Medium	2-10m	✓	✓		✓
9	Medium	2-10m	✓			
10	Medium	2-10m	✓	✓		
11	Small	<2m	✓			
12	Small	<2m	✓			
13	Small	<2m	✓			
14	Small	<2m	✓			

Source: CAA, 2011a, CAA, 2012; airport websites

There was considerable variation in the modal split at each airport. Airport 2 had the highest public transport mode share (47.3%) whilst Airport 14 had the lowest (1.3%). They all have on-going surface access mode share targets which are detailed either in their surface access strategy or Master Plan.

3.2.3 Conducting the interviews

The interviews were conducted between July and October 2010, with each interview lasting between 45 minutes and 1 hour. Two of the interviews were conducted using Skype, while the remaining interviews were conducted in person at the relevant airports.

A week before each interview the participant was contacted by e-mail to ask their permission for the interview to be recorded on a Dictaphone so that the interview could be transcribed for the purpose of analysis. The e-mail also included a list of the questions that were to be asked in the interview (see Table 3.1). It was felt that participants would be more inclined to allow the interview to be recorded if they knew the content of the interviews beforehand.

On the day of the interview the participants were again asked whether they were happy for the interview to be recorded, and were assured of their anonymity. During the interview itself notes were taken by the researcher. Immediately after completion of each interview an interview analysis sheet was completed (see Appendix A). In addition to practical information relating to the date, time and location of the interview, these sheets included key points and issues raised during the interview. Any similarities and/or differences with other interviews were also noted down, as well as any problems that were encountered and their possible implications for future work. For example, one of the early interviews was conducted, at the interviewee's request, in a public area, which unfortunately proved too noisy for a clear recording. Quieter venues were therefore subsequently sought for the remaining interviews.

3.2.4 Analysing the interviews

The recordings from the interviews were then used to construct interview transcripts for the purpose of analysis. Schmidt (2004) states that the analytical techniques used to analyse semi-structured interviews are driven by a number of factors, including the goals and questions of the study, the methodological approach, and the resources available to the researcher. A thematic analysis approach was subsequently selected for analysing the transcripts. Thematic analysis is a method for identifying, analysing, and reporting patterns (or themes) within qualitative data. As Braun and Clarke (2006) note, in practice thematic analysis is often used to refer to a wide range of analytical techniques such as discourse analysis, but varies from grounded theory in that its aim is not to add to existing theory. Because thematic analysis does not require the detailed theoretical knowledge of techniques such as grounded theory, for example, thematic analysis is favoured by many qualitative researchers (Braun and Clarke, 2006).

As there was already some idea of the themes covered in the interview (see Table 3.1), the analysis here can be considered as a ‘deductive thematic analysis’, as opposed to an ‘inductive thematic analysis’ where few assumptions are made about the structure of the data and analysis proceeds in a more ‘bottom-up’ fashion (Braun and Clarke, 2006). Initially, a number of broad categories were established via examination of the transcripts. Generally, categories matched those outlined in Table 3.1, although other issues did emerge during the analysis. For example, security issues brought in as a result of the September 11th 2001 and the Glasgow Airport 2007 terrorist attacks were mentioned by several participants. Sections were also categorised according to their relevance to the questions identified from the literature, as shown in Section 3.1. The various categories identified from the transcripts were then collated, analysed and revised to produce a strict coding frame. Each of the transcripts was then coded a final time according to the coding frame. Coded sections within the text were highlighted and then collated with those from other transcripts to aid comparative analysis.

Overall, the thematic analysis identified four key areas; the positive and negative impacts of private vehicle access, encouraging public transport use, responding to external market conditions, and strategic management options. The findings for each of these are discussed in the following section.

3.3 Interview findings

3.3.1 The positive and negative impacts of private vehicle access

The surface access problem and the need for airports to reduce the share of private vehicle journeys were addressed in Section 1.2 and Section 2.2. Overall, this was seen as *the* overarching issue for surface access managers, and *"….the lens through which all surface access policies are now viewed" (Airport 1, large).* An example of a typical response to questions about the sorts of surface access issues currently facing airports was:

> *"I think the main issue is that we've got a very strong direction from the 2003 Air Transport White Paper to encourage modal shift. I think it is right that we encourage that shift towards public transport, but allied to that there's a need to invest in public transport more generally." (Airport 5, medium)*

Initiating modal shift and reducing private vehicle access was primarily viewed as being a traffic congestion and environmental issue. Medium sized and larger airports especially noted that congestion on motorways and roads accessing the airport were consistently a problem during peak hours. While surface access was identified as being *"one of the biggest contributing factors to airport emissions" (Airport 5, medium),* high private vehicle use and congestion was also noted as having a deleterious impact on customer service and perceptions of the airport, thus having the potential to negatively affect business.

“The most important thing in my opinion about surface access is you have to think of it as part of the wider customer service package. If you can't get to an airport by the mode of choice you choose, in a way that you feel comfortable, then that's going to have an impact on repeat business.” (Airport 4, medium)

For large airports and those located in regions with several competing airports, reliable and efficient surface access travel was identified as being a key airport competition issue. As one manager at a large airport stated, surface access was *“…driven by the need to expand the catchment area and make us more competitive, as well as increasing public transport use.” (Airport 1, large)*

The situation at smaller airports was slightly different. Generally speaking, the commercial benefits of passenger car parking were considered to outweigh the negative environmental impacts or problems of congestion, which were seen as less of a problem at medium sized and smaller airports given the lower passenger numbers. Passenger car parking revenues are perhaps especially important for smaller airports given that they are likely to be more susceptible to changes in the economic climate and falling passenger numbers. As one manager stated:

“We’ve got targets to meet about delivering more people by public transport, and rightly so, but I do work for a company who make money from car parking, and I have to remind myself of that sometimes…we have to watch out for the bottom line as well.” (Airport 4, medium)

Although it may appear counter intuitive, car parking revenues can actually play an important role in maintaining frequent public transport services. At smaller airports it was noted that in some cases these revenues are used to subsidise existing public transport services. One manager spoke of the importance of car parking revenues for funding local bus routes.

> *“Car parking revenues are essential from a revenue perspective as they directly support bus routes. Without car parking revenues I don’t have a budget.” (Airport 7, medium)*

While passengers who drive and park at the airport provide commercial benefits for airports in terms of car parking charges, there are no such benefits associated with passengers who are dropped-off or picked-up. In effect these trips represent a double negative for airports, seeing as they are both environmentally and commercially damaging. The disproportionate commercial and environmental impact of these trips was highlighted by the vast majority of participants.

> *“Our big problem is the kiss-and-fly journey to the airport. We've probably got the highest modal share for kiss-and-fly and, for our size, the highest volume as well. So that's our dominant issue, managing and switching that into either public transport or car parking.” (Airport 3, large)*

While all airports were keen to reduce the share of drop-off/pick-up journeys, their motivations for doing so varied. For larger airports with higher passenger numbers drop-off/pick-up trips were considered to pose serious problems in terms of traffic congestion and increased vehicle emissions. For example, one manager at a large airport stated that drop-off/pick-up journeys currently accounted for 42% of the airports controllable carbon emissions (i.e. all terminal operations but not aircraft movements) but only represented 20% of all trips at the airport. Congestion problems were noted as being especially acute on terminal forecourts and kerb side areas where vehicles congregate. Security directives designed to limit vehicle access to the front of the terminal implemented partly as a result of the terrorist bombing at Glasgow Airport in 2007, may exacerbate these problems. The additional traffic generated by these trips can also put extra pressure on surrounding roads and short term car parking facilities.

"From our perspective drop-off is a kerb space issue. The security constraints forced upon us have put extra pressure on our forecourts, and the number of people getting dropped-off are causing congestion and adding to problems on the motorway." (Airport 2, large)

In contrast, at smaller airports where the potential for congestion is perhaps less acute, drop-off/pick-up journeys primarily pose a problem regarding lost revenue for the airport in terms of passenger car parking and money being spent in airport food and retail facilities by people accompanying passengers. Several participants also spoke about the use of charges at some airports to discourage passengers from being dropped-off. In some cases it was thought that the motivations for implementing such charges were not necessarily a result of desires to reduce congestion and environmental impacts.

> *"Congestion is not an issue for us. The big issue with kiss-and-fly is more of a commercial one to be honest, and it's not just about the loss of parking revenues but also about dwell times and people being in the terminal. Some airports are going down the route where if you want to drop someone off at the airport you have to pay for the privilege of doing that, and that's not necessarily to do with environmental issues, it's to do with the commercial*

realities of running the business and trying to maximise revenues as any business would." (Airport 14, small)

Taxi journeys share several key similarities with drop-off/pick-up journeys, but were not considered to pose the same sorts of problems as drop-off/pick-up by managers. This is presumably because taxis are easier to monitor and control than drop-off/pick-up journeys. Typically, airport operators will sell taxi firms licenses granting them rights to operate at the airport. These license fees add to airport revenues and enable the airport operator to maintain a balance between supply and demand of taxis on the airport site. As Ashford et al. (2013) note, in the UK it is also increasingly common for taxis to incur a charge for both a drop-off and pick-up at an airport, which may act as a further source of income.

While it was recognised that there had been falling passenger numbers at most airports as a result of the economic downturn, it was felt that in the medium to long term problems of congestion and increased environmental impacts were likely to get worse rather than better as a result of shortfalls in capacity, especially at larger airports. Several managers spoke of the need to adopt more flexible approaches to surface access planning to try and accommodate any future fluctuations (either up or down) in passenger levels. The issue of congestion was also discussed in relation to proposed airport expansion in the south-east of England, which would need to *"…consider the surface access implications of these proposals as a matter of priority." (Airport 1, large)*

3.3.2 Encouraging public transport use

As addressed in Section 2.1, through the development of ATF and ASAS airports must set targets and develop strategies for increasing public transport use. Consequently, encouraging airport users to use these modes was highlighted as a key challenge by managers in the study. Much of the difficulty relates to accommodating the varying requirements, characteristics, perceptions and preferences of different groups of airports users (see Section 2.3), as well as the fact that smaller airports do not typically have the required passenger numbers to support regular public transport services.

The need for a better understanding of the factors governing mode choice was highlighted as being particularly important for encouraging modal shift.

> *"What I'd really like, although it would be difficult to find, is to work out what are the factors that would make people change to public transport…my job would be a lot easier if I knew what it was that people needed to change to public transport." (Airport 5, medium)*

Providing efficient and reliable journeys for passengers who are generally highly time sensitive and anxious about missing their flight was identified as being of key importance.

> *"…there are time requirements on your travel, your check-in, making it through security, you have to get there by particular times. Your time is valuable, you want to minimise the time you are travelling, you want to get to that meeting or wherever when you said you'd be there." (Airport 5, medium)*

Trip purpose was identified as having an important influence on mode choice. Business and leisure passengers were thought to vary primarily in terms of their relative valuation of time and cost factors. Because travel costs are generally covered by the employer, business passengers were thought more likely to use so called 'premium' services such as dedicated rail services like the Heathrow Express. Some managers also thought that the need to reduce journey time was especially important for business passengers given their work commitments. The notion that business passengers place a higher value on their time than leisure passengers but a lower value on the cost of their trip supports similar findings by Pels et al. (2003) and Hess and Polak (2006). Business passengers were also generally considered to travel more frequently than leisure passengers. While some felt that this would mean business passengers were more likely to use public transport, others felt that the costs and unreliable nature of using these modes would encourage business passengers to use private vehicle modes instead.

Managers were keenly aware of the challenges associated with providing public transport options for airport users travelling in the early morning or late at night, as it was felt that generally options at these times were more limited. At smaller airports, even where passengers wanted to travel by public transport they may be prevented from doing so by a lack of suitable services. This was noted as representing an important barrier to increasing public transport use.

> *"How can we make rail better for people and passengers getting to the airport? Do we have trains running in the early morning? No, we don't. Do we have trains at weekends in the way we'd like them? No, we don't. Is the network twenty-four-seven? No, it isn't." (Airport 4, medium)*

Accommodating passengers carrying luggage is also a key factor in encouraging public transport use. Generally it was felt that public transport services were not sufficient in catering for airline passengers, who had to share space with normal commuter journeys and travel in carriages or buses that were not designed with the comfort of people carrying bags in mind. It was thought that passengers may also be deterred from choosing public transport if they had to make changes along their journey (for example from a bus to train or between trains). Further difficulties could arise for passengers travelling in groups. These people were thought unlikely to travel by public transport because private cars or taxi were generally more cost effective options.

> *“Think about a family with two adults and two children and how viable it is for them to use public transport, with all the luggage and various interchanges that entails. Unless they live in the city centre, it makes it unviable.” (Airport 5, medium)*

For passengers visiting the UK, rather than those travelling on the outbound leg of their journey, there may be greater scope for increasing public transport use because these people will typically not have access to a car for their journey.

> “*Passengers coming from overseas is something that’s been attractive to us here, because the inbound market doesn’t have private cars to jump in. Some may have friends and relatives picking them up, but the vast majority will rely on good public transport.” (Airport 6, medium)*

Airports with a higher proportion of inbound passengers may therefore experience a higher overall mode share of public transport. Journey origin was also considered an important factor in determining public transport users. Passengers travelling from home were thought to be more likely to have access to a car, and thus were more likely to travel to the airport by car. In contrast, those travelling from work were considered more likely to travel by taxi or public transport.

Mode choice decisions may also be influenced by general mode choice behaviour. At one large airport, for example, it was suggested that the relatively high proportion of passengers accessing the airport by taxi reflected the high use of taxis in the region as a whole. It was considered that passengers who used a mode regularly for their daily travel were more likely to also choose it for their surface access travel. Employees on the other hand pose a separate set of challenges. While passengers may be put off from using public transport because of luggage considerations or the costs associated with group travel, for employees public transport may simply not be a viable option given the regular nature of their travel. Participants noted, often from their own experience, that local bus services were either slow, unreliable, or didn't serve the areas in which employees needed to travel from.

A major impediment to increasing employee public transport use also relates to the fact that airport companies typically offer free or subsidised parking for their staff. This can make it challenging for airports to encourage employees to switch to public transport, as there is little financial incentive for them to do so. One manager at a medium sized airport, for example, spoke from an employee perspective and asked rhetorically:

> *"Why would you get the bus when you can park at the airport for free?"* (Airport 4, medium)

Charging employees directly for parking or limiting demand in other ways was not considered desirable by any of the participants, however, for fear of straining employee and tenant relations.

> *"If we were to say "employees can't park or they've got to pay £50 a week to park", we'd have a mutiny on our hands, and probably no employees!" (Airport 6, medium)*

In addition to issues of journey cost, the increased reliability, comfort and convenience afforded by private car travel in comparison with public transport was also seen as a reason for the current situation.

> *"As we all know, I think that people just like the convenience of stepping out of their front door, jumping into their car, going to work and parking in a car park pretty much outside the front door." (Airport 6, medium)*

With regard to developing strategies for increasing employee public transport use there seemed a preference for incentive measures such as travel plans or preferential spaces for people who car share, rather than restrictive disincentive measures. However, it was noted that such schemes were often limited in their scope because in most cases the significant majority of employees were not employed directly by the airport operator, and as such only limited influence could be exerted.

Notwithstanding the difficulties associated with accommodating the needs of different airport users, increasing public transport use at smaller airports, in particular, can be challenging given that they typically do not have the required passenger numbers to support regular public transport service.

"For an airport such as ours we simply don't have enough passengers to make regular bus services commercially viable. You can subsidise them, but that is obviously expensive." (Airport 11, small)

While managers at some airports noted that subsidies were used to support public transport services (for example, see Section 3.3.1), this appeared to be a less favoured option for smaller airports.

3.3.3 Responding to external market conditions

As discussed in Section 2.6, due to the commercialised and privatised nature of airport infrastructure and transport services airports face a significant challenge with regards to coordination and integration of surface access planning with the various stakeholders involved. This is as much an issue for smaller airports as it is for larger ones.

"We're not in control of it [surface access] as a company, but it has a huge impact on us. The roads are owned by the Highways Agency and local authorities. The train companies operate the train services, Network Rail look after the infrastructure, the bus and coach companies provide the bus services. So, how they do this and how we network and work with them is of vital importance." (Airport 3, large)

To achieve sustained mutually beneficial business relations with stakeholders, it is vital that airports are able to marry the often conflicting commercial agendas and priorities of a wide range of different stakeholders.

> *“You’re dealing with a group of people whose agendas are driven by central government and a group of people whose agendas are purely driven by commercial interests. So the relationships are different but we have to weld those together to deliver the kind of services we would like to see delivered by the airport.” (Airport 3, large)*

Failing to build productive relationships with stakeholders may have serious implications for airport competition. At one airport it was noted that significant efforts had been made to improve the quality of the rolling stock on one of the main rail links into the airport, as customer feedback had been very negative. The train operator, however, refused to upgrade their rolling stock as it was not deemed a worthy investment on their part. Subsequently, several major airlines decided against commencing operations from the airport and cited the poor quality of this particular rail service as the key reason for their decision.

Consequently, establishing mutually beneficial business relationships with stakeholders was identified as being a key issue by airport managers.

> *“It all comes down to money. If you can get the train companies and the airlines to work together and they can make some money out of it, they’ll do it. If they can’t, they won’t. It really is as simple as that.” (Airport 4, medium)*

In this regard ATF were seen to be valuable vehicles for helping to facilitate dialogue between stakeholders, although in some cases it was noted that meetings were held only once or twice a year.

As discussed in Section 2.6, surface access planning needs to be flexible enough to adapt to changes in external market conditions in the aviation industry. In the last decade or so the growth of low-cost carriers, in particular, has been instrumental in altering patterns of surface access behaviour (see Pantazis and Liefner, 2006).

While not all of the participants in the study were located at airports with a particularly strong ‘low-cost’ presence, a number of them felt that travelling on a low-cost carrier altered a passenger’s travel behaviour. Passengers flying on low-cost carriers, almost by definition, are typically travelling on a budget, and thus may be even more motivated to minimise the total cost of their journey. For passengers spending more than a few days away from home, using public transport may be a more attractive financial option than parking their car for the duration of their trip.

> *“Now clearly budget is important to you so you’ll be saying “Well, I want to keep the surface access element of getting to the airport cheap.” So you will use other forms of surface access. You won't use your car necessarily. You will look to use the train, you will look to use the bus and coach to get to the airport, and there’s evidence of that.” (Airport 4, medium)*

Low-cost carriers are strongly associated with the ‘short break’ and ‘visiting friends and family’ leisure market. Several participants suggested that the short nature of these trips meant that passengers were less likely to be travelling with heavy luggage, which could make public transport more of an attractive option. Further, it is common for low-cost carriers to charge passengers an extra fee for checking in hold luggage, and this may encourage passengers to limit the size and number of bags they carry with them.

It has been suggested that passengers flying on low-cost carriers may be prepared to travel further to their departure airport in order to take advantage of lower air fares (Pantazis and Liefner, 2006; Lian and Rønnevik, 2011). This was not a view shared by any of the interviewees however, as whilst this may have been the case in the past where low-cost operations were limited to only a small number of airports, the growth of low-cost carriers in the UK means that a much larger number of airports now have low-cost operations, and passengers subsequently do not have to travel so far to access low fares. The effect of flying low-cost on a passenger's travel behaviour for their journey to the airport thus appears more a function of what these trips represent (i.e. short haul, short duration, predominantly leisure trips) rather than any new or unique characteristic associated with low-cost carriers.

3.3.4 Strategic management options

As discussed in Section 2.7, a range of options are available for surface access managers including construction of new infrastructure, expansion of existing facilities operational measures and behavioural change initiatives.

Overall, there was a clear preference for 'softer' measures and providing airport users with behavioural incentives rather than enforcing more draconian market-based or demand management measures. These 'harder' measures were seen as being distinct from the normal yield management of passenger car parking costs, which was viewed primarily as a means for maximising revenue, rather than as a demand management measure in its own right. Providing incentives, rather than disincentives, was considered important given the need to continually satisfy customers and employees in a highly competitive market.

> *"I have always been of the opinion that it's easier and better if you can use carrots and incentives, as sticks carry with them difficult issues." (Airport 4, medium)*

In this instance, *'difficult issues'* referred to problems of customer dissatisfaction which could lead to a loss of business and perhaps negative publicity for the airport. The controversy incurred by drop-off/pick-up charges was commonly highlighted as an example of how airports need to be careful with the strategies they implement. It was felt that one of the main reasons for the unpopularity of drop-off/pick-up charges was because passengers were still relatively unfamiliar with them, and resented them as a result. Subsequently, it might be the case that opposition to market-based measures such as this may wain as they become more familiar and common place in other areas.

> *"People get used to a particular way of doing things. You think nothing of paying a fiver to park your car in a city centre for a couple of hours shopping, but to pay a pound at an airport? It's terrible, awful!" (Airport 4, medium)*

As a result, improving the level of service and customer experience offered by public transport services was identified as preferable to reducing the attractiveness of private vehicle access. Various strategies were discussed including the refurbishment and renewal of rail stock, provision of real time information boards, and reconfiguration of terminal forecourts to improve the visibility and convenience of bus stops.

It was felt that behavioural change strategies were likely to stand the best chance of success when they were targeted at specific groups of airport users. One participant spoke of an advertising campaign where the airport had attempted to reduce the share of passengers being dropped-off/picked-up at the airport by running a poster campaign carrying the slogan "He's your Dad, not a taxi driver: Take the train to and from the airport and give your loved ones a lie in." The posters were designed to encourage younger people to travel to the airport by rail rather than be dropped-off. The posters were geographically targeted at areas located close to rail stations on the service's route.

Incentive measures are also favoured for dealing with employee issues. This is largely because demand management measures, such as limiting car parking space, or market-based measures, such as charging employees directly for car parking permits, are seen to risk straining employee relations. A number of participants spoke about schemes such a subsidised travel cards or the provision of shower and locker facilities for staff wishing to cycle to work. The focus seems to be on achieving small incremental changes rather than wholesale shifts in behaviour.

> *"We have always tried to put the message out to our employees that it's a small change and it's not the case of throwing your car keys away and never using the car again, we're saying we want people to choose but to choose responsibly. If everyone chooses an alternative to the car at least some time in their week or every couple of weeks then that's the sort of change that can make a difference." (Airport 4, medium)*

However, it is important that these strategies are shown to yield tangible commercial benefits for the airport operator. For example, at one airport it was noted that because fewer employees were travelling by car they had managed to close a section of the staff car park and cancel the shuttle bus operation to it. This was estimated as representing a saving of £100,000 a year for the airport. Some managers noted that getting surface access issues recognised as a priority by top level management was sometimes challenging, especially during times of falling traffic levels.

> *“It’s a challenge for me to communicate to the rest of the business why surface access is important. Because that’s what you need to think about as well, most of the people running an airport are concerned with day to day operations. It’s about getting planes in, people in, planes out, people out. They don’t understand why surface access is important, why you get things done, how you get things done and why it takes so long.” (Airport 5, medium)*

As discussed in Section 2.7.2, construction projects and key infrastructure improvements are generally lengthy and expensive propositions for airports. At larger airports, where future capacity constraints are likely to be more of a problem, there was a general recognition that expansion projects were likely to be necessary in the medium to long term. For example, one large airport had recently spent £3 million increasing the capacity of their terminal forecourt area because of congestion from passenger drop-off journeys. Other proposed initiatives such as expanding public transport terminals, construction of new waiting areas and ticketing facilities were also highlighted.

In the longer term, arguably the greatest challenge facing airport managers is the need to successfully implement and maintain long lasting behavioural change among airport users.

> *“Actually getting people to use a service and change what they've always done and their ancestors have done is probably the biggest challenge. How do you get your customer base and your employees to do something different to what they've always done and what their instincts tell them to do?” (Airport 4 medium)*

Understanding the factors that determine surface access behaviour, and then where necessary developing interventions to change it, was considered likely to form a significant part of surface access management for the future.

3.4 Conclusions

Chapter 3 builds on the issues identified in the literature review by providing a valuable management perspective on the challenges, implications and future directions of surface access at UK airports, and fulfils the second research objective. As well as building on and providing a deeper insight into the various issues and themes identified in the literature, the semi-structured interviews with airport managers sought to answer three important research questions (i-iii).

Initially, it was necessary to establish *“how the nature and scale of surface access issues vary between UK airports, and whether some issues are unique to particular airports (research question i).”* This is an important question in terms of the applicability of the research findings and the recommendations that arise from them. From a detailed analysis of the interviews it would seem that a clear distinction exists between large airports and small airports in a surface access context. For larger airports the dominant issues relate to problems of severe traffic congestion (particularly at peak times) on airport roads and terminal forecourts, and associated negative environmental impacts in terms of increased vehicle emissions. Provision of efficient, reliable travel is also a major issue for large airports in terms of airport competition and increasing the size of its catchment area.

The challenges facing smaller airports are slightly different. While passenger car parking plays an important commercial role for all airports, it is perhaps especially vital for smaller airports given the lower passenger numbers. Because of this, problems of traffic congestion are also not on the same scale as they are at larger airports. Instead, the major challenge for smaller airports is the need to maximise the revenue potential of this crucial source of income. Smaller airports also face significant challenges in encouraging public transport use as they typically do not have the required passenger numbers to support regular services.

While the specific nature of the issue faced by airports vary, the need to reduce the share of drop-off/pick-up trips is a problem common to them all. For larger airports these journeys pose problems in terms of extra traffic generation and congestion on airport roads and lack of curb side capacity. Drop-off and pick-up journeys are also detrimental from a revenue perspective because passengers do not pay car parking fees. It is this which forms the primary cause for concern among smaller airports, who are perhaps less concerned by problems of congestion but are acutely aware of the negative commercial impacts these trips have. As such, the need to reduce drop-off/pick-up trips is of significant importance to airports in the UK.

The interviews also sought to establish whether *"certain strategies are considered to be more effective or preferred by airport managers than others (research question ii)."* With regards to implementing strategies for reducing private vehicle trips and encouraging public transport use, managers appear to favour using 'softer' incentive measures rather than 'harder' disincentives. While yield management of passenger car parking costs is a market based measure employed at almost all airports, it is considered primarily as a means of revenue generation rather than as a demand management measure. With regards to passenger access, the tendency to favour 'carrots' rather than 'sticks' is driven by considerations of customer service/perceptions and airport competition, whereas for employees it is more about maintaining good staff relations.

As to whether certain approaches are more or less successful it is hard to say, given that airports and their particular circumstances vary considerably; a successful strategy at one airport may be totally inappropriate elsewhere. Considering the current economic climate, the high expense and the lengthy planning and implementation processes (not to mention possible political objection) typically involved with construction of key infrastructure, it would seem that, for the time being at least, simply increasing capacity is unlikely to be a viable option for all but perhaps the very largest airports. While airports may favour implementing measures such as employee travel cards or better provision of travel information, it is unclear whether these incremental changes are really enough to tackle the root causes of the surface access problem. Instead, it seems likely that achieving meaningful change in surface access travel behaviour will require a better, deeper understanding of the factors governing travel behaviour. As one manager noted, "…*my job would be a lot easier if I knew what it was that people needed to change to public transport." (Airport 5, medium).*

As the research seeks to provide recommendations for airport decision makers for reducing private vehicle use it was necessary to determine *"the likely future directions of surface access policy (research question iii)."* While operational measures, physical improvements and market-based measures will continue to be valuable strategic options for dealing with surface access issues in the future, there is a growing recognition of the need to tackle the root causes of the surface access problem by examining the underlying determinants of peoples travel behaviour. In order to change behaviour it is important to first understand it and examine the factors that make some people choose one mode, and other people choose another. It is thought that future strategies are likely to stand the greatest chance of success when they are targeted at specific groups of airport users or market segments who share similar characteristics and the potential to change their behaviour.

Overall, while the review of the literature and interviews with airport managers have highlighted a wide range of issues, arguably the most important (both in terms of scope and timescale) is the issue of high private vehicle use by passengers at large airports. As noted, large airports are problematic from a surface access perspective because of the high passenger numbers they handle and the resulting congestion and severe environmental impacts. Passengers pose a problem because of the complexity of their trip characteristics and travel requirements, and the fact that the significant majority of them choose to travel to and from airports by private vehicles. Reducing drop-off/pick-up journeys was also identified as a key issue by managers in the interviews, which is almost exclusively a passenger issue. This group of airport users are also important from an airport management perspective because they represent the airport's primary customers.

Clearly there is a need to develop strategies that reduce the share of private vehicle journeys and simultaneously increase public transport use. For this to happen, however, a number of important questions must be addressed. A key issue relates to assessing the various personal, situational and spatial factors that characterise surface access mode choice. While there is a growing body of work examining the varying requirements and characteristics of passengers (Section 2.3.1), there is a need for a greater understanding into how these considerations actually translate into mode choices.

In particular, given that drop-off/pick-up trips confer such a disproportionate commercial and environmental impact (Section 3.3.1), examining the myriad of factors associated with this mode is of key importance. Establishing whether certain passengers are more or less likely to choose drop-off/pick-up than others, and whether certain situational factors relating to the passenger's trip could be used to indicate their propensity to use drop-off/pick-up would be valuable for airport managers and permit more informed decision making and robust policy development.

While it is generally accepted that passenger mode choice is motivated by factors such as the relative cost, comfort and convenience of different modes (Ashford et al., 2013), there is a need to examine how, if at all, the role of these factors varies for different *modes*, rather than just for different passengers. There is a need to consider whether certain modes are more or less strongly associated with certain attributes, and whether factors such as cost are more important for passengers travelling by particular modes than others. Establishing *why* passengers behave in the way they do, rather than just *how* they behave, also provides a deeper foundation on which strategic decisions can be made.

The issue of behavioural change and modal shift is a key theme of UK transport policy (DfT, 2011b), as described in Section 2.2. It also forms a central component of ASAS (Section 2.2) and was highlighted as a key goal by airport managers (Section 3.3.4). It is unlikely that widespread construction of new surface access infrastructure or the implementation of disincentive market based measures will occur in the near future, and even then it is unclear whether these would be sufficient alone to achieve the changes required. Consequently, it is necessary to adopt a psychological approach to examining surface access travel behaviour, looking at the various factors that influence individual travel behaviour. An important question, therefore, relates to establishing the attitudinal factors that may cause passengers to switch modes. In other words, what are the factors that cause passengers to travel by public transport rather than by private vehicles? Subsequently, this information can help to develop targeted behavioural change strategies that ‘tap into’ the key factors governing behaviour, and help identify groups of people where these strategies are likely to stand the greatest chance of success.

The following chapter outlines the theoretical underpinning of the research by introducing two socio-psychological theories of attitude behavioural relations, the Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991). Both theories have been used extensively in the field of travel behaviour research including studies examining the psychological antecedents of public transport use, but have not so far been systematically applied to the issue of airport surface access in the UK.

Chapter 4

Psychological theories of travel behaviour

4.1 Introduction

Chapter 4 details the theoretical underpinning of the research. In the previous chapter a series of semi-structured interviews were conducted with airport managers responsible for surface access management at UK airports. The interviews highlighted a need to examine the underlying psychological and attitudinal determinants of surface access travel behaviour. This issue is particularly acute with respect to passenger travel at large airports due to the complex nature of passenger travel decisions, the problems associated with large volumes of drop-off/pick-up journeys and the increased levels of surface access congestion experienced. Given the need to understand the psychological and attitudinal determinants of travel behaviour, the present chapter considers two psychological theories of attitude-behaviour relations commonly used in travel behaviour, the Norm-Activation Theory (Schwartz, 1997) and the Theory of Planned Behaviour (Ajzen, 1991).

In Section 4.2, the use of psychological theories in a travel behaviour context is addressed. This is followed, in Section 4.3 and 4.4, by detailed descriptions of the Norm-Activation Theory and the Theory of Planned Behaviour, respectively. Given the growing levels of empirical evidence supporting the use of a combined approach incorporating elements of both theories, Section 4.5 addresses the relative merits and drawbacks of adopting a combined theoretical approach. Further evidence that supports adding additional psychological constructs onto the two theories to improve their performance is presented in Section 4.6. This is followed by Section 4.7 which addresses the application of psychological approaches to travel behaviour for policies for reducing private vehicle use. A conclusion is then provided at the end of the chapter in Section 4.8.

4.2 Psychological theories of travel behaviour

A key focus of travel behaviour research relates to identifying and understanding the factors that determine mode choice decisions. As Salomon and Mokhtarian (1997) state, travel behaviour research traditionally considered mode choice decisions purely in economic terms. Travel was assumed to be both a temporal or financial cost that people sought to minimise wherever possible. Consequently, early travel behaviour research commonly employed well established economic theories of choice, such as rational choice theory.

In the last decade or so travel behaviour research has expanded to include psychological determinants of behaviour. This shift coincided with increased awareness of the negative impacts of car use and a growing focus on explaining pro-environmental behaviour in academic research. To an extent, psychological approaches to travel behaviour can be considered as a conscious departure away from the traditional focus on socio- demographic or econometric factors (Heath and Gifford, 2002).

There is now a significant body of research that concerns the psychological determinants of mode choice, including; the role of social value orientation and trust in others (Van Lange et al., 1998); environmental concern and awareness of the problems caused by car use (Garvill, 1999); and the effects of increased awareness on mode choice (Garvill et al., 2003). While useful studies in their own right, they were initially only exploratory in nature and as a consequence have lacked an integrated theoretical framework. These early studies also tended to investigate the role of different psychological variables but without a clear theoretical framework, so understanding how the various different constructs related to one another was problematic (Bamberg and Scmidt, 2003).

More recently, studies focusing on the psychological antecedents of mode choice have employed established socio-psychological theories of attitude behaviour-relations. The two most influential and commonly used theories in travel behaviour research in recent years have been the Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991). One of the main advantages of using such theory-driven models is that they contain precise operationalization of the theoretical constructs used and specify the causal processes through which they affect behaviour (Bamberg and Schmidt, 2003). Aside from their simple, yet sophisticated nature, a further advantage is that extra psychological constructs can be added or subtracted from their theoretical frameworks to suit particular research contexts.

While both the Norm-Activation Theory and the Theory of Planned Behaviour have been used in travel behaviour research, they each adopt a very different perspective in their attempts to explain human behaviour. At the most basic level, the Theory of Planned Behaviour (Ajzen, 1991) emphasises the role of personal utility maximisation on behaviour, arguing that behaviour is most clearly determined by intention and perceived control over an action. In contrast, the Norm-Activation Theory (Schwartz, 1977) suggests that behaviour is governed predominantly by an individual’s own personal moral convictions, which predispose him/her to behave in a certain way.

Chapter 3 has already demonstrated the obligation of airport surface access managers to appreciate the behavioural underpinnings of passengers using their respective facilities. Failure to acquire an accurate understanding of why travellers behave as they do, and how and why they choose particular transport modes will severely limit the ability of planners and managers to achieve desired change in the future.

It is therefore necessary to analyse the salient aspects of the two most widely used theories in more detail, in order to evaluate which, if either, is likely to be of maximum benefit in the present context. Sections 4.3 and 4.4 therefore examine the Norm-Activation Theory and the Theory of Planned Behaviour, respectively.

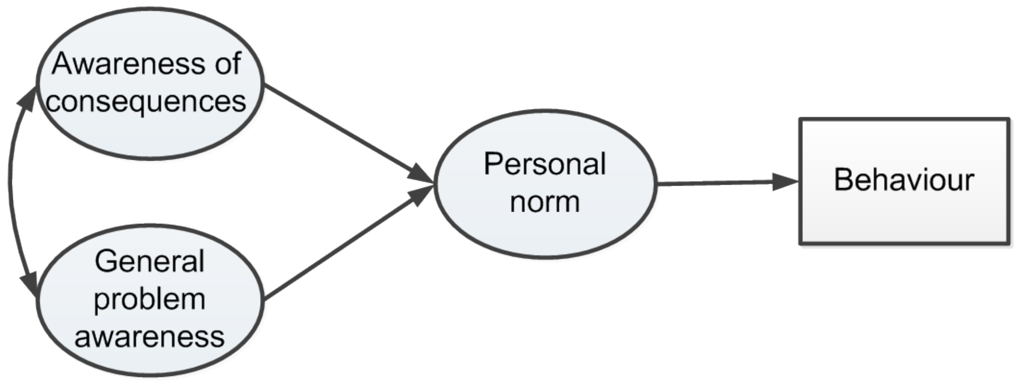
4.3 The Norm-Activation Theory

The Norm-Activation Theory (Schwartz, 1977) was developed in the context of explaining pro-social, altruistic behaviour; actions that require some sort of personal sacrifice for the greater benefit of others (Abrahamse et al., 2009). Consequently, the relevance of the Norm-Activation Theory in a travel behaviour context relies to a significant degree on the extent to which travel behaviour can be viewed as a morally guided decision.

The central assumption of the Norm-Activation Theory is that feelings of personal moral obligation (known as personal norms) are the only causal determinants of behaviour (Bamberg et al., 2007). Personal norms (or moral norms, as they are sometimes referred to) can be described as *“a personal conviction that some forms* *of behaviour are inherently 'right' or 'wrong'…"* (Manstead, 2000, p12). Behaviour in accordance with these personal norms may lead to a sense of pride, whereas behaviour that contradicts one's personal norms may result in feelings of guilt (Abrahamse et al., 2009). In a travel behaviour context this may relate to someone feeling a moral obligation not to use their car because of the increased noise and atmospheric pollution this would cause (Bamberg and Schmidt, 2003).

The process of norm activation involves two further constructs. According to the original conceptualisation of the theory as proposed by Schwartz (1977), personal norm is determined by 'awareness of consequences' (perceptions that there will be negative consequences if the person does/does not act) and a measure of responsibility (defined as a general tendency towards responsibility denial). This latter construct later became known as 'ascription of responsibility'.

More recently, studies focusing specifically on pro-environmental behaviour have replaced the 'ascription of responsibility' construct with a measure pertaining to the general awareness or perception of the problem in question (see Nordlund and Garvill, 2003; Bamberg et al al., 2007; Klöckner and Blöbaum, 2010). The 'general problem awareness' construct reflects Stern's (2000) construct of 'perceived ability to reduce threat', which forms part of his adaptation of the Norm-Activation Theory, the Values-Beliefs-Norms theory. In a travel behaviour context the 'general problem awareness' construct typically reflects one's own perceptions of the severity of particular issues, such as traffic congestion or increased environmental impacts from vehicle emissions. Figure 4.1 shows a schematic representation of the Norm-Activation Theory. The following section discusses the components of the Norm-Activation-Theory in greater detail.



Source: Adapted from Schwartz, 1977.

Figure 4.1 Schematic representation of the Norm-Activation Theory. Note that the second determinant of personal norm is listed as 'General problem awareness', which reflects recent alterations to the theory for use in explaining pro-environmental behaviour. Traditionally, this construct related to 'Ascription of responsibility'.

4.3.1 Personal norm and Behaviour

Schwartz (1977, p227) defined personal norm as *"self-expectations for specific action in particular situations…experienced as feelings of moral obligation".* Personal norms are markedly different from subjective norms (as used in the Theory of Planned Behaviour); while the latter taps into perceptions of approval or disapproval from significant others, personal norms refer to an individual's conviction that acting in a certain way is right or wrong. In other words, a person is motivated to comply with their own personal norms not for fear of incurring social sanctions or disapproval, but to avoid anticipated self-related feelings of regret or guilt (Bamberg et al., 2007). The scope of personal norms is thus limited to behaviours that have a moral dimension (Hunecke et al., 2001).

As already noted, a central assumption of the Norm-Activation Theory is that personal norms are the direct antecedent of behaviour. Personal norm has been shown to be a useful predictor of a wide range of behaviour, including pro-environmental behaviour (see Guagnano et al., 1995; Stern et al., 1993; Thøgersen, 1996) and travel behaviour. A number of studies provide support for the use of personal norm as a predictor of travel behaviour. Bamberg and Schmidt (2003) showed that personal norm had a significant negative effect on car use for university journeys among a sample of 254 university students in Germany. In the study personal norm explained 14% of the variance in behaviour. These findings are supported by similar research by Nordlund and Garvill (2003), who found that personal norms had a significant influence (β=0.44) [1] on willingness to reduce personal car use among a sample of 1,467 car owners in Sweden.

4.3.2 Awareness of consequences

Schwartz (1977, p229), defined the awareness of consequences construct as a *"tendency to become aware of the consequences of one's behaviour for others".* Whereas personal norm reflects the moral dimension of behaviour, awareness of consequences describes the perceived causal relationship between behaviour and the consequences of these actions (Hunecke et al., 2001). Unlike personal norm, which is assumed to affect behaviour directly, the awareness of consequences construct influences behaviour indirectly by moderating personal norm. A number of studies support its use as a useful predictor of pro-environmental behaviour (Dietz, Stern, & Guagnano,1998; Guagnano et al., 1995; Tarrant & Cordell,1997).

In travel behaviour research the awareness of consequences construct is often modified to reflect the particular context of the study. Bamberg et al. (2007), for

[1] In their study, Nordlund and Garvill (2003) employed structural equation modelling (path analysis) to assess the influence of values, problem awareness and personal norm on willingness to reduce car use. In structural equation modelling the strength of predicted causal relationships between variables are expressed as standardised path coefficients (β), which represent standardised versions of linear regression weights as used in linear regression.

example, used the term ‘awareness of negative consequences caused by own car use’ in their study of public transport use in two urban agglomerations in Germany. In the two study contexts they found that awareness of the impacts of car use was significantly linked to feelings of guilt (β=0.63 and β=0.45 respectively), which subsequently led to greater feelings of moral obligation (personal norm) to use public transport. Similar findings are reported by Hunecke et al. (2001), who used subjective norm, feelings of guilt and awareness of consequences to predict personal norm in a modified version of the Norm-Activation Theory applied in the context of mode choice in Germany. Overall, they found a good correlation between the awareness of consequences construct and personal norm (β=0.24).

4.3.3 General problem awareness

In its original form, the second determinant of personal norm in the Norm-Activation Theory related to responsibility, which was defined as a general tendency towards responsibility denial (Schwartz, 1977). Later on this construct became known as ‘ascription of responsibility’.

While some studies have shown that ‘ascription of responsibility’ can be a useful predictor of ecological behaviour (Guagnano et al., 1995; Abrahamse, 2009), recent studies of pro-environmental behaviour have tended to replace it with a measure of an individual’s general awareness of the problem in question (Nordlund and Garvill, 2003; Bamberg et al al., 2007). General problem awareness relates to the extent people are conscious of the problem at hand, and their perception of the possibility for reducing it (Nordlund and Garvill, 2003). It has been shown to be an important antecedent of pro-environmental intentions and behaviour (Klandermans, 1992; Grob, 1995; Stern, 2000). One of the main reasons such studies have not treated ‘ascription of responsibility’ as a separate construct is that the causal effects of individual behaviour on the environment are assumed to be already contained in the ‘awareness of consequences’ construct (Hunecke et al., 2001). Like the ‘awareness of consequences’ construct, ‘general problem awareness’ (or ‘ascription of responsibility’, depending on which version of the Norm-Activation Theory is being used) is thought to influence behaviour indirectly.

General problem awareness has been shown to be a useful predictor of travel behaviour. Bamberg et al. (2007), employed two measures of general problem awareness *(“Car use is one of the main environmental problems,”* and *“There is an urgent need for something to be done about the environmental pollution caused by car use”)* to predict public transport. In their study conducted in Frankfurt, general problem awareness was strongly correlated with personal norm (β=0.36), which in turn accounted for 36% of the explained variance in public transport use.

4.4 The Theory of Planned Behaviour

The Theory of Planned Behaviour (Ajzen, 1991) takes a very different perspective of behaviour (Abrahamse et al, 2009). While the Norm-Activation Theory focuses on the role of personal morals in decision making, the Theory of Planned Behaviour stresses the role of selfish considerations of maximising personal benefits. Also, whereas Schwartz (1977) limited the applicability of his theory to the domain of altruistic behaviours, the Theory of Planed Behaviour (Ajzen, 1991) was developed as a general action theory for use in a wide range of behavioural domains (see Conner and Armitage, 1998 for a review), including travel behaviour research (for example, Hunecke et al., 2001; Heath and Gifford, 2002; Bamberg et al., 2003; Bamberg et al., 2007).

A central assumption of the Theory of Planned Behaviour is that intention is *the* key antecedent of actual behaviour. It assumes that if alternative behaviours exist, a choice is made based on the relative strengths of the intentions to perform each one (Bamberg et al., 2011). In this sense the Theory of Planned Behaviour can be considered an extension of rational choice theory, as it assumes that people make rational decisions based on selfish considerations of maximising personal benefits. Behavioural intention is considered to be causally determined by three psychological constructs; attitude, subjective norm and perceived behavioural control (Bamberg et al., 2003; Bamberg et al., 2007):

- *Attitude*: a person's general feelings of approval or disapproval towards an action.
- *Subjective norm*: perceptions of approval or disapproval from one's significant others concerning the performance (or not) of a particular behaviour.
- *Perceived behavioural control*: a person's perceptions of the extent to which a behaviour will be easy or difficult to perform.

Ajzen (1991) further posited that the concept of attitude is correlated with subjective norm and perceived behavioural control, while subjective norm is also correlated with perceived behavioural control. The theory argues that each of these three components is causally determined by a different set of salient beliefs; behavioural beliefs inform attitudes, normative beliefs underlie subjective norm and control beliefs form perceived behavioural control (Heath and Gifford, 2002).

In some situations, perceived behavioural control is considered to have a direct predictive effect on behaviour as well as the intention to perform the behaviour in question. This can occur when an individual's *perceived* behavioural control matches the *actual* amount of behavioural control they are able to exercise (Bamberg et al., 2007). The addition of the perceived behavioural control construct is the main way in which the Theory of Planned Behaviour adds to its predecessor, the Theory of Reasoned Action (Ajzen and Fishbein, 1980). Consideration of perceived behavioural control as an additional antecedent of behaviour is important, as it extends the applicability of the Theory of Planned Behaviour beyond easily performed, volitional behaviours (covered by the Theory of Reasoned Action) to include complex goals and outcomes which may be dependent on performance of other related behaviours (Conner and Armitage, 1998).

Both the Theory of Planned Behaviour and the Theory of Reasoned Action can be described as general action theories, as they are intended to underpin a wide range of behavioural domains (Ajzen, 1991). Figure 4.2 shows a schematic representation of the Theory of Planned Behaviour, and highlights how it differs from the Theory of Reasoned Action.

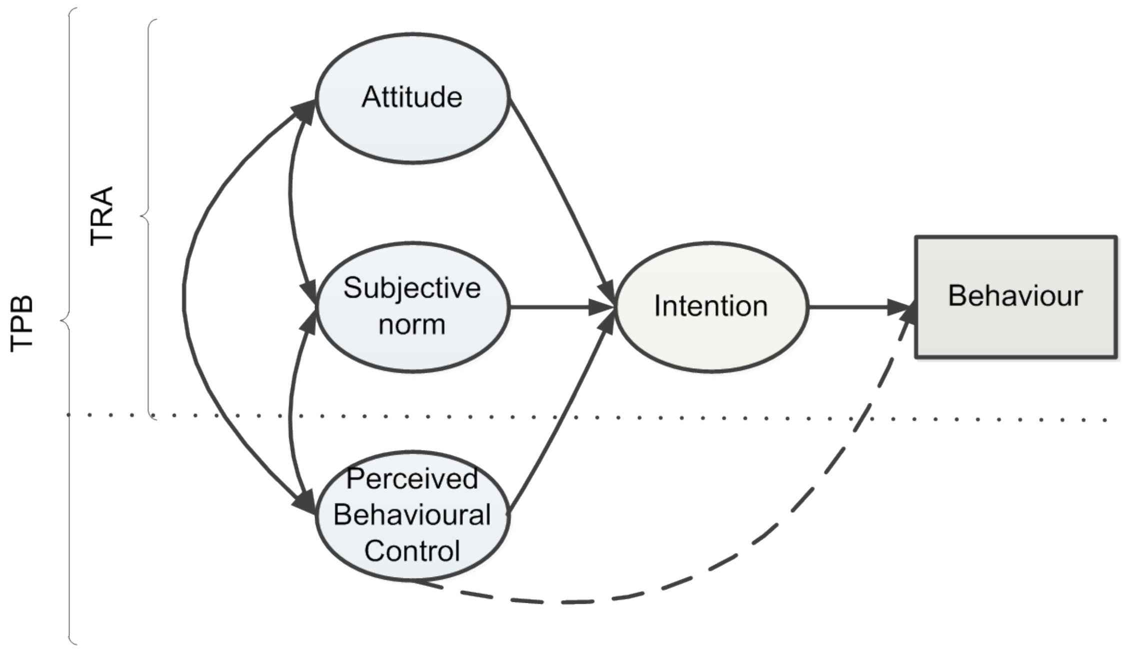
The Theory of Planned Behaviour provides a good framework for explaining travel behaviour for the three main reasons outlined by Haustein and Hunecke (2007):

- It contains the central predictors of travel behaviour.

- It contains only five parameters (at least in its original form), and is therefore easy to explore in a survey context.

- Its flexibility means that it is open to the inclusion of extra constructs should the study require it.

The following sub-sections address each of the components of the Theory of Planned Behaviour in more detail.



Source: Adapted from Ajzen, 1991

Fig 4.2 Schematic representation of the Theory of Planned Behaviour (TPB) and the Theory of Reasoned Action (TRA). Note that in some cases perceived behavioural control can be a direct predictor of behaviour (shown as a dashed arrow).

4.4.1 Intention and Behaviour

The cognitive concept of intention, and the link to actual behaviour, lies at the heart of the Theory of Planned Behaviour (Sheeran, 2002). Intention can be defined as *"…instructions that people give to themselves to behave in certain ways"* (Triandis, 1980, p203). Put concisely, it is a summary of all the pros and cons a person takes into consideration when deciding to perform (or not perform) a behaviour (Bamberg et al., 2007).

Intentions have been used to predict and explain a wide range of behaviours, including travel behaviour (see Conner and Armitage, 1998 for a review). The extent to which intention can predict behaviour has been the subject of both narrative (Ajzen, 1991) and meta-analytic review (Armitage and Conner, 2001). In their meta-analysis of 48 studies employing the Theory of Planned Behaviour (including but not limited to travel behaviour), Armitage and Conner (2001), found that the average correlation between intention and behaviour was r=0.47, which is consistent with other similar studies. For example, Sutton (1998) conducted a meta-analysis of 9 meta-analyses and quantitative reviews of the Theory of Planned Behaviour and the Theory of Reasoned Action. The correlation between intention and behaviour reported in the studies ranged from r=0.44 to r=0.62, while overall the models explained between 19-38% of the total variance in behaviour. Importantly, similar results have been reported in travel behaviour research. In a study of mode choice among 254 university students in Germany, Bamberg and Schmidt (2003) report a fairly strong correlation (β=0.60) between intention and self-reported car use.

Inevitably, the relationship (or correlation) between intention and behaviour is not perfect. Clearly, the intention to perform a behaviour does not automatically and inevitably result in its execution. Whilst a necessary condition for behaviour, an intention to behave in a particular way is not necessarily sufficient on its own. This ‘mismatch’ or ‘gap’ between intention and behaviour has therefore been the focus of much academic research (see Sutton, 1998, Sheeran, 2002). This has aimed not only to explore other relevant factors which might influence actual behaviour in a positive way, but also the identification of barriers to the translation of intention into behaviour.

Ajzen and Fishbein (1980) suggest that two main factors determine the strength of the correlation between intention and behaviour. The first is the correspondence between the measure of intention and behaviour, as it is important that this exactly mirrors the action, time, target and context of the behaviour being studied. For example, if the behaviour in question relates to public transport use for journeys to work in the city of London, it is necessary but not sufficient simply to measure an individual's intention to use public transport in general. The second factor is the degree to which intentions remain stable over time. Clearly someone's intentions can change over time. The longer the time period between measuring intention and actual behaviour, the more likely it is that some 'new' variable will be introduced that changes the person's intention and their ultimate decision.

The introduction of 'new' variables such as this may also result in the introduction of new feedback loops into the decision making process. For example, you may have intended to return home from your holiday by air but, for whatever reason, you were forced to travel home by a different mode instead. This new mode of travel could be found to be much better or worse than your perception of your originally planned flight. Subsequently a feedback loop has been introduced that either positively enforces or negatively impacts upon your originally intended outcome. Consequently it is important to minimise the amount of time between measuring intention and actual behaviour is therefore desirable when gauging behavioural intention.

In evaluating the performance of the Theory of Planned Behaviour with respect to the intention-behaviour relationship, however, it is important to recognise that the theory was designed to be simple and uncomplicated (Sutton, 1998). Considering that intention is only predicted by three constructs in the Theory of Planned

Behaviour (in its original form), its performance is impressive. Effects are commonly interpreted in light of Cohen's (1988) guidelines; 0.1-0.3 = small effect, 0.3-0.5 = medium sized effect, >0.5 = large effect. On this basis the correlation between intention and behaviour reported in the meta-analysis by Sutton (1998) would be described as a 'medium' to 'large' effect. Results from travel behaviour research, such as the study by Bamberg and Schmidt (2003), also support the validity and use of intention as a direct antecedent of behaviour.

4.4.2 Attitude and Behavioural beliefs

According to the Theory of Planned Behaviour, intention is causally determined by three psychological constructs; attitude, subjective norm and perceived behavioural control. The first of these constructs, attitude, has its roots in social-psychology (Bohner and Wänke, 2002). Various definitions of attitude exist, some assuming that attitudes are largely learned while others suggest that there is some sort of biological basis (Bohte et al, 2009). The concept of attitude in the Theory of Planned Behaviour "…*reflects the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question"* (Ajzen, 1991, p188). It is assumed that attitudes develop from existing salient beliefs (behavioural beliefs) about the behaviour or object. When forming an attitude, people link the behaviour or object with certain attributes, other objects and certain characteristics or past events. Each belief then leads to the formation of an expected outcome of the behaviour, or to some other attribute such as the perceived costs incurred by performing it (Ajzen, 1991).

Attitude, as conceptualised by Ajzen (1991), incorporates both instrumental and affective evaluations of behaviour. In the context of travel behaviour, instrumental evaluations typically relate to the practical aspects of travelling, such as speed, convenience, flexibility, reliability and monetary cost (Salomon and Mokhtarian, 1997). Affective factors on the other hand refer to the emotions evoked by travelling, such as stress, excitement, pleasure, and boredom (Anable and Gatersleben, 2005). In a study of student mode choice for university journeys, for example, Bamberg and Schmidt (2003) took ratings of the flexibility, speed, comfort (instrumental evaluations) and stress (affective evaluation) of driving for 254 university students in a German town. Combined, the various ratings were used to predict overall attitudes towards driving. Attitude itself was then measured by asking respondents to rank whether car commuting was good/bad, pleasant/unpleasant on a 5 point bipolar scale. Their findings showed a perfect relationship, with the four instrumental and affective measures explaining 100% of the variance in actual attitude.

The use of attitudes as determinants of travel behaviour has generally received strong empirical support in the literature. Gardner and Abraham (2008) conducted a meta- analysis of 23 studies that used psychological constructs associated with the Theory of Planned Behaviour to explain and predict mode choice. Overall, attitude to car use demonstrated a moderate effect on behaviour (r_+=.27)[2], while attitude to non-car use was shown to have a medium to large effect on behaviour (r_+=-.41). However, some of the studies included in the meta-analysis showed significant variation from this. For example, in a study of mode choice among 199 respondents in the Netherlands, Verplanken et al. (1994) found that attitude to non-car use only had a moderate effect on actual mode choice (r_+=.29, compared with r_+=-.41 overall). It is therefore highly probable that the link between attitude and behaviour varies

[2] Gardner and Abraham (2008) report r_+ statistics, which are correlation coefficients transformed into Fisher's Z scores, weighted by the sample size, and then back transferred to give a weighted average effect.

according to contextual, spatial and temporal criteria, and is still imperfectly understood.

While Ajzen's (1991) conception of attitude is most commonly used in travel behaviour research, some studies have treated the instrumental and affective elements of attitude separately. Anable and Gatersleben (2005), for example, studied the role played by instrumental and affective evaluations on mode choice for leisure trips and journeys to work. For the latter, instrumental factors such as flexibility, convenience, cost and predictability were perceived to be more important in mode choice decisions than affective evaluations (stress, control, freedom, relaxation and excitement). In comparison, for leisure journeys it was found that instrumental and affective evaluations were perceived to be of roughly equal importance in mode choice decisions. Interestingly, in a study of commuter mode choice among 113 commuters in Rotterdam, Steg (2005) found that mode choice for journeys to work was most strongly related to symbolic (social pressure) and affective motives (pleasure and arousal) than instrumental factors, which were based on attitudinal measures as proposed by the Theory of Planned Behaviour. While these findings may support the case for treating instrumental and affective evaluations separately, studies such as Gardner and Abraham (2008), provide sufficient justification for the use of the attitude concept, as conceptualised by Ajzen (1991) in travel research.

4.4.3 Subjective norm and Normative beliefs

The second predictor of intention in the Theory of Planned Behaviour is subjective norm. This term is used to describe the perceived social pressure to perform, or not, a particular behaviour. According to Ajzen (1988, p117) *"…people intend to perform* *a behaviour when they evaluate it positively and when they believe that important others think they should perform it"*. Subjective norm is a product of normative beliefs, which are concerned with the perceived likelihood that important individuals or groups will approve or disapprove of one performing a given behaviour (Ajzen, 1991).

Subjective norm has been shown to be a motivational factor in mode choice decisions (Steg et al., 2001). Bamberg and Schmidt (2003) established that subjective norm was strongly correlated to self-reported mode choice for university journeys among students. It was found to be a stronger predictor (β=0.40) of intention than attitude (β =0.32) and perceived behavioural control (β=0.25). These findings were also corroborated by Hunecke et al. (2001), who found that subjective norm influenced self-reported use (or not) of the subway for everyday journeys among 160 randomly selected respondents in Germany (β=0.19).

The extent to which subjective norms influence mode choice remains in question however, as some studies have revealed only weak links between it and overall mode choice. Abrahamse et al. (2009), for example, found that subjective norm did not significantly explain intention to reduce car use for journeys to work among a sample of 241 office workers in Canada, when the other psychological variables included in the study were controlled for. Similarly Klöckner and Matthies (2004), demonstrated only a weak correlation between subjective norm and self-reported mode choice for journeys to work when it was used as a regression predictor alongside two other psychological variables, personal norm and habit.

The inconsistent performance of subjective norm in predicting mode choice may be explained by the construct, as conceptualised by (Ajzen, 1991), failing to take account of all possible social influences on behaviour. Bamberg and Schmidt (2003, p280), argue that subjective norm *"is probably too narrow to reflect all the social factors influencing the intention building process. It only reflects the influence of perceived social pressure and not the influence of more internalized, self-generated expectation as the self-ascripted social role".*

4.4.4 Perceived Behavioural Control and Control beliefs

The third predictor of intention in the Theory of Planned Behaviour is perceived behavioural control, which is what differentiates the Theory of Planned Behaviour from its predecessor, the Theory of Reasoned Action. Perceived behavioural control can be described as the perception of the extent to which a given behaviour will be easy or difficult to perform (Ajzen, 1991). As already noted, when an individual's perception of control matches the amount of actual control s(he) is able to exercise, perceived behavioural control can be considered as an additional direct antecedent of behaviour (Bamberg et al., 2007). It is formed from control beliefs, which refer to feelings about the presence of factors that either help or hinder the performance of the behaviour (Ajzen, 1991).

The concept of perceived behavioural control as used in the Theory of Planned Behaviour has its origins in Bandura's (1982) concept of perceived self-efficacy, which is defined as *"judgments of how well one can execute courses of action required to deal with prospective situations"* (Bandura, 1982, p 122). Ajzen (2002), argues that a measure of PBC is important in predicting behaviour, as even strong intentions to perform an action may not be sufficient if people feel that performing it is too difficult.

Perceived behavioural control has been shown to be a good predictor of travel mode choice. Haustein and Hunecke (2007), for example, found that perceived behavioural control (β=0.49) was a stronger direct predictor of the use of environmentally friendly transport modes than intention (β=0.19), in their study of mode choice in 3 large German cities. Similarly, Harland et al. (1999) demonstrated that perceived behavioural control (r=0.68) had a stronger influence on intentions to use alternative modes to the car than attitudes (r=0.54), subjective norm (r=0.34) or personal norm (r=0.59) in a study of 198 respondents in the Netherlands. It should be noted, however, that perceived behavioural control in this case was only measured using a single item *("If I wanted, I could in most instances use other forms of transport than the car during the next 6 months")*. Normally it is desirable to measure constructs with several items to avoid potential sources of error or bias.

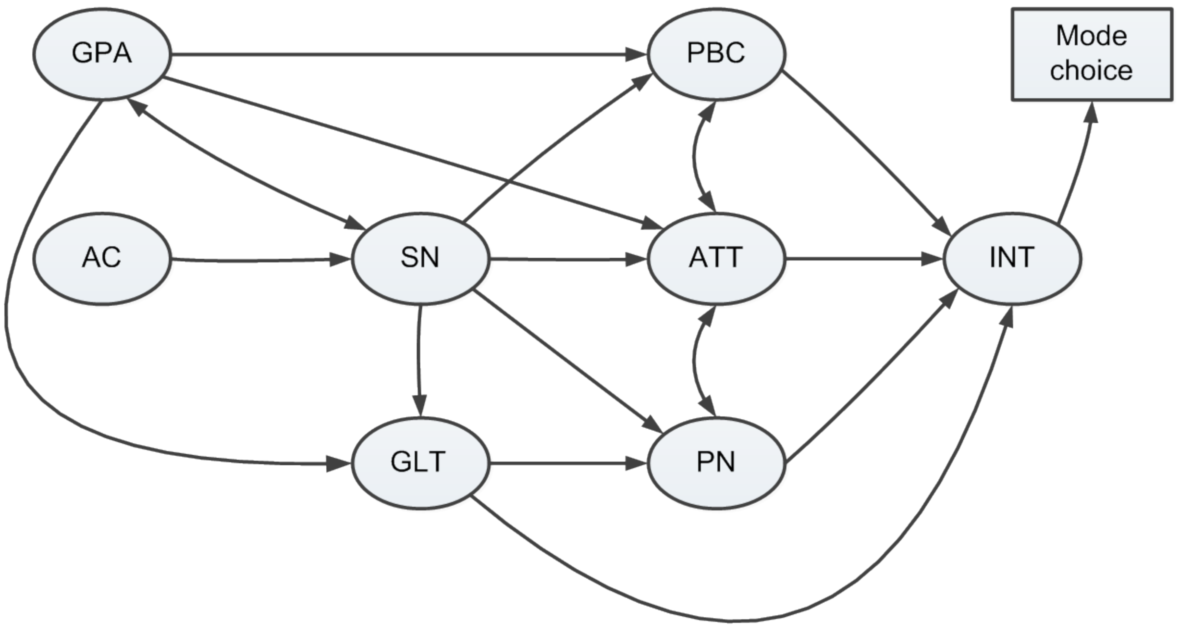
In contrast, other studies have shown that perceived behavioural control is not a good predictor of mode choice. In a study of 437 respondents in Germany, Bamberg et al. (2007) found that perceived behavioural control had no additional impact on predicting the use of public transport over and above the other constructs in the study. One possible explanation for the poor performance of perceived behavioural control in this instance is that as a concept it is also too narrow and does not tap into all aspects of perceptions of control. Ajzen (2002), suggests that it could be improved by incorporating a measure of both perceived controllability (beliefs about whether one could perform the behaviour if one wished) and perceived self-efficacy (an individual's confidence in his/her ability to perform the behaviour in question). Similarly, others have suggested that perceived behavioural control could be improved by reconstructing it to include measures of perceived ease/difficulty and perceived controllability (Trafimow et al., 2002).

4.5 A combined theoretical approach

The Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991) have each received empirical evidence for explaining and predicting travel behaviour as well as a host of other behaviours. This presents a potential problem for researchers, however, as they have to decide which theory is more appropriate in any given situation. There remains considerable disagreement as to whether travel behaviour is guided by moral, normative influences (Norm-Activation Theory), or by calculations of personal utility and self-interest (Theory of Planned Behaviour) (Bamberg and Schmidt, 2003).

While some authors argue that it is best to identify the domain in question and then apply the appropriate model (Lindenberg and Steg, 2007), others suggest a combined theoretical approach containing elements of both the Theory of Planned Behaviour and the Norm-Activation Theory is likely to yield better, more robust findings (Matthies, 2003). Bamberg and Möser (2007), suggest that this combined approach stems from the growing awareness that pro-environmental behaviour, in particular, is best viewed as a mixture of self-interest and concern for other people (Bamberg and Möser, 2007). Harland et al. (1999) used an altered version of the Theory of Planned Behaviour, which included a measure of personal norm, to investigate four pro-environmental behaviours, including intention to use alternative modes of travel to the car, among a sample of 305 people in the Netherlands. It was shown that personal norm was an important predictor of behaviour over and above the original constructs of the Theory of Planned Behaviour. Personal norm had a significant influence on intention to use (β=0.16), and actual use (β=0.37), of alternative modes of travel to the car.

Bamberg et al. (2007), used a similar approach in the context of daily travel behaviour, which is shown in Figure 4.3. In addition to the original constructs of the Theory of Planned Behaviour, the hypothesised model included measures of personal norm, general problem awareness, awareness of negative consequences caused by own car use and anticipated feelings of guilt. Personal norm replaced subjective norm as a direct determinant of intention, whereas subjective norm's effect on intention was posited as being mediated via its impact on perceived behavioural control, attitude, personal norm and anticipated feelings of guilt. Personal norm especially was found to be a significant influence on intention to use public transport, explaining 36% of the variance in public transport use among citizens in Frankfurt.



Source: Bamberg et al. 2007

Figure 4.3 Schematic representation of the joint model proposed by Bamberg et al. (2007), in the context of predicting mode choice among residents in two German urban agglomerations. GPA=General Problem Awareness, AC=Awareness of Consequences, SN=Subjective Norm, GLT=Anticipated Feelings of Guilt, PBC=Perceived Behavioural Control, ATT=Attitude, PN=Personal Norm, INT= Intention.

The joint model proposed by Bamberg et al. (2007), was then later re-assessed by Bamberg and Möser (2007). Using the pooled correlations from 46 studies relating to the psychological determinants of pro-environmental behaviour, they tested the combined model using structural equation modelling. They found that intention was best used to mediate all other psychological constructs in the model, and that it explained 27% of the total variance in behaviour. In addition to attitude and perceived behavioural control, personal norm was also found to be a significant antecedent of behavioural intention (52% of explained variance combined). In turn, feelings of guilt, social norm, responsibility, and problem awareness were found to account for 58% of the variance in personal norm. Gardner and Abraham (2008) conducted a similar meta-analysis of 23 studies relating to the psychological determinants of car use reduction. It was found that the pooled correlations (r) were similar to those in the study by Bamberg and Möser (2007), thus supporting the use of the combined theoretical approach in a travel behaviour context.

A similar approach was later used by Gardner and Abraham (2010) in the context of predicting car use among a sample of 190 residents in a large UK city. Their combined theoretical approach incorporated all of the constructs from the Theory of Planned Behaviour as well as personal norm and general problem awareness from the Norm-Activation Theory. The hypothesised model also included two extra constructs; descriptive norm and efficacy, which are discussed in the following section. Overall, the model performed well with intention (which was posited as being the main antecedent of car use) explaining 57% of the variance in behaviour. In turn, 49% of the variance in intention was predicted by its various antecedents; car-use attitudes, perceived behavioural control, descriptive norm, non-car use attitudes, subjective norms, and personal norms.

4.6 Additional psychological determinants of travel behaviour

One of the main strengths of both the Norm-Activation Theory and the Theory of Planned Behaviour is that due to their uncomplicated nature they are relatively easy to apply in a research context (Haustein and Hunecke, 2007). On the other hand, this arguably makes them too simplistic for explaining complex behaviours, especially when they are applied in their original forms. Ajzen (1991) and Schwartz (1977) were well aware of these potential limitations, and explicitly stated that additional psychological constructs could be added to their theoretical frameworks as the specific research context dictated.

As noted, some authors have questioned the role of subjective norm as an effective determinant of travel behaviour (Abrahamse et al., 2009; Klöckner and Matthies, 2004). As a result, several studies have incorporated an additional psychological construct relating to descriptive norm, which can be defined as what is perceived to be typical or 'normal' behaviour in a given context (Cialdini et al., 1990). It is suggested that the perception of what most people do in a situation motivates others to act in the same way, as it shows what behaviour will be effective. Heath and Gifford (2002), for example, found that descriptive norm significantly improved the prediction of bus use in two studies (β=0.25 and β=0.26) of university students in Canada.

Other authors have attempted to improve the predictive ability of the two theories by including a measure of efficacy, which refers to perceptions about what can be achieved (Axelrod and Lehman, 1993). For example, Anable (2005), showed that efficacy was a useful predictor of mode choice in a sample of day trippers in the UK. Bamberg et al. (2007), on the other hand, added a measure of anticipated feelings of guilt to improve the prediction of mode choice for every day travel among German citizens. The construct was designed to elicit whether people thought that they would feel guilty or not about using a particular mode, the implication being that people may feel guilty about using their car rather than alternative modes. The study found that anticipated feelings of guilt were strong antecedents of personal norm (β=0.36 and β=0.60, respectively), but were not significant as determinants of intention directly.

As well as complex behaviours, the Theory of Planned Behaviour and Norm-Activation Theory also have limitations with regard to predicting repetitive behaviour. When a behaviour is triggered automatically, without the mediation of attitudes or intention, it is considered to be habitual (Verplanken et al., 1994). In the Theory of Planned Behaviour past behaviour is thought to influence attitude formation, which in turn influences intention and then finally behaviour. It is often noted that an individual's daily travel patterns repeat themselves over periods of time (Gärling and Axhausen, 2003), and as a result travel behaviour studies have often incorporated a measure of habit.

Travel habits have been shown to be useful predictors of travel behaviour. In a study of travel behaviour by university students, Bamberg and Schmidt (2003) tested a combined theoretical model containing elements of the Theory of Planned Behaviour, Norm-Activation Theory and Triandis' (1977) Theory of Interpersonal Behaviour, which includes a measure of habit. Habit was found to have a stronger effect on self-reported mode choice (β= 0.41) than any of the other factors. Similarly, Matthies et al. (2002) demonstrated that habit was a strong predictor of self-reported car and subway use among a random sample of 187 citizens living in the city of Bochum, Germany.

While such findings appear to support the use of habit as an extra predictor of travel behaviour, as a construct it is, almost by definition, most suited to situations where the journey in question is undertaken regularly, such as the journey to work or school. As such, it would seem counter intuitive to incorporate a measure of habit in the context of passenger surface access travel; a journey explicitly regarded as one that is undertaken relatively infrequently (de Neufville and Odoni, 2003).

Beyond additional psychological constructs, some studies have also attempted to account for situational influences on travel behaviour. Situational influences in the context of travel behaviour typically relate to specific observed variables; such as car availability (Simma and Axhausen, 2001), the purpose of the trip (Dieleman et al., 2002), travel disruptions (Lo and Hall, 2006) or the weather (Jakobsson, 2004). One of the main limitations of both the Norm-Activation Theory and the Theory of Planned Behaviour, according to Klöckner and Blöaum (2010), is that they reduce the influence of situational factors on behaviour to perceived behavioural control. Importantly, while one’s attitudes or outlook are thought to remain fairly stable over time, situational variables can change very quickly. This has prompted some authors to try and account for situational influences in these models.

In a study of commuter mode choice among a sample of 205 university students in Australia, Collins and Chambers (2005) found strong correlations between situational aspects related to the cost of, and access to, public transport compared with the car and psychological variables like environmental beliefs about car use. Similarly, Hunecke et al. (2007) used situational, socio-demographic and psychological variables as predictors of mode choice for every day trips in Germany. They found that each of the three domains contained significant predictors of mode choice.

4.7 Psychological approaches to travel behaviour and measures for reducing private vehicle use

Recognition of the problems associated with increasing private vehicle use has led to a number of travel behaviour studies focusing on how people may be encouraged to reduce their private vehicle use and switch to more sustainable modes. Studies have included examinations of the behavioural responses to particular technologies or policy measures, such as pricing instruments (Steg, 2003; Gehlert et al., 2008; Francke and Kaniok., 2013), travel information systems (Chorus et al., 2006) and voluntary travel behaviour change (Bamberg et al., 2011).

Steg (2003) examined the acceptability of a policy package for reducing car use that included higher fuel prices, tolls, closure of city centres to cars and inclusion of road taxes in the cost of fuel. It was found that the factors relating to acceptance of the policy package were awareness of driving related problems, attitudes to car use, feelings of individual responsibility, outcome efficacy and perceptions about the travel behaviour of others. Interestingly, it was suggested that in some instances raising the costs of private vehicle use does not lead to behavioural change as people may perceive a 'right' to drive if they feel they are paying a high price to do so.

Tertoolen et al. (1998) examined automobile use among 350 car users in the Netherlands in order to identify the psychological barriers to reducing car use. In the study respondents were provided with information regarding the environmental and/or financial costs of their travel to examine to what extent this affected their travel behaviour. While this new information was found to affect individual attitudes, this was not translated into changes in travel behaviour. In accordance with their findings the authors suggested that while information provision may change *attitudes*, it does not necessarily change *behaviour.*

Tertoolen et al. (1998) also suggest that people may respond negatively to being told that they cannot use their car and instead try to exert control over the situation by using their car more often. Similar recommendations are made by Stradling et al. (2000), who examined the attitudes of car drivers in the UK (*n*=791) in order to highlight those likely to reduce their car use. They liken the dilemma of reducing car use to discouraging other undesirable behaviours, and that it is generally more effective to suggest alternative behaviours and provide procedural assistance rather than simply telling people not to behave in a certain way.

Zhang et al. (2013) investigated the effect of travel information provision on attitudes towards travel behaviour. They compared people who had, and had not, received information as part of the household "TravelSmart" programme, which was implemented in Adelaide, Australia. While they found that the informed inhabitants had a greater stated willingness to reduce their car use than the non-informed group, the former were more likely to cite inadequate public transport provision as a barrier to reducing their car use. The authors suggest that 'soft' policy options need to be supported by suitable 'hard' alternatives if behavioural change initiatives are to be successful.

People are more likely to be motivated to change their behaviour when they are rewarded for performing positive actions than reprimanded for behaving in a negative way. Tillema et al. (2013) compared the effectiveness of two congestion management schemes in the Netherlands, one road pricing scheme and one that rewarded people for avoiding travel at peak times. They found that the scheme that rewarded people for positive behaviour was a better motivator of change than the road pricing scheme. This idea that incentives are better than disincentives is consistent with the views of airports managers discussed in the previous chapter.

4.8 Conclusions

Chapter 4 details the theoretical underpinning of the research, which relates to two socio-psychological theories of attitude-behaviour relations, the Norm-Activation Theory and the Theory of Planned Behaviour.

Both theories have received empirical evidence in the literature for their application in a wide range of domains, including travel behaviour and mode choice. Research by Bamberg et al. (2007), and various meta-analyses of Theory of Planned Behaviour research, such as the one provided by Gardner and Abraham (2008), provide suitable justification for a Theory of Planned Behaviour approach in explaining and predicting mode choice. Similarly, positive findings from studies employing the Norm-Activation Theory, such as Nordlund and Garvill (2003) and Hunecke et al. (2001), lend credence to the notion that travel behaviour and mode choice is, at least to some degree, a morally guided decision.

As studies by Bamberg et al. (2007), and Gardner and Abraham (2010) have shown, there is increasing support for the use of a combined theoretical approach to travel behaviour that incorporates all, or parts of, both the Theory of Planned Behaviour and the Norm-Activation Theory. Intuitively, a combined approach makes sense considering that travel behaviour and mode choice can quite easily be conceived as possessing both a personal utility and a moral element.

The simple, uncomplicated nature of the Theory of Planned Behaviour and the Norm-Activation Theory is both an advantage and a potential weakness. While their relatively simple nature makes them easy to apply in a travel survey context, their ability to predict complex behaviour has been questioned. Increasingly, therefore, studies have attempted to address their shortcomings by including additional psychological constructs. While the body of research remains small at present, the available literature variously supports the inclusion of additional constructs such as descriptive norm, behavioural efficacy, anticipated feelings of guilt and habit in a travel behaviour context.

This chapter raises several important issues that are relevant to the present research. While the Norm-Activation Theory and the Theory of Planned Behaviour have received empirical support in travel behaviour research, it is notable that in the vast majority of cases the type of journey being studied is a fairly frequent or 'every day' trip such as travelling to work or college. In contrast, comparatively little attention has been paid to the use of social psychological theories in the context of explaining a less frequently undertaken trip such as the journey to the airport. As noted, surface access journeys are unusual in that passengers are likely to be staying away for long periods of time, travelling in groups, carrying heavy luggage with them and may be dropped-off/picked-up (Ashford et al., 2013). This research is novel in that it uses the Theory of Planned Behaviour and Norm-Activation Theory in the context of more specialised form of travel behaviour.

Similarly, many of the studies reviewed here have necessarily been conducted in a single urban centre. Whereas business travellers might be expected to regularly visit a single airport, at broadly similar times of day, leisure travellers rarely do so, being far more likely to travel to a larger number of airports but to do so only occasionally, and at different times of the day. Their opportunity for learned or 'habitual' behaviour is thus more constrained. Intuitively, one would expect the two sets of circumstances to consequently invoke different behavioural intentions.

Important research questions are also raised. While the Theory of Planned Behaviour emphasises the role of personal utility and self-interest, the Norm-Activation Theory considers behaviour to be driven by feelings of personal moral obligation. An important research question here therefore relates to whether "*surface access travel to airports is guided predominantly by moral, normative influences or by more selfish considerations of self-interest (research question vi).* This issue is important for airport decision makers because the approach needed to change a morally guided behaviour is very different from that required to alter a behaviour driven purely by feelings of personal interest.

There also exists an alternative view that recognises that behaviour (including travel mode choice) can have both selfish and moral elements to it. This combined theoretical approach is reflected by work by Bamberg et al. (2007) and Gardner and Abraham (2010), among others. A subsequent question therefore relates to whether "*a combined theoretical approach is more appropriate than either the Norm-Activation Theory or the Theory of Planned Behaviour in their original forms when explaining decisions to travel by alternative modes to airports (research question vii)."*

Constructs such as efficacy (Anable, 2005), descriptive norm (Heath and Gifford, 2002), and anticipated feelings of guilt (Bamberg et al., 2007) have all been shown to be useful additional determinants of travel behaviour in other contexts, although not for surface access travel. As such the research seeks to add to existing research into the use of additional psychological constructs in established socio-psychological theories by determining whether *“measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy useful additional predictors of decisions to travel by alternative modes to (airports research question viii)”.*

The theoretical underpinning of the research feeds into the following chapter, where it will help guide and inform the research design. This acts as a framework for the research, as it helps to determine what data needs to be collected and how it will be obtained. It will also aid the development of the specific research methods that will be used for analysis.

Chapter 5

Research Design and Methods

5.1 Introduction

Chapter 5 outlines the research design adopted, the data required, and the methods employed to fulfil the overall aim of the research. As stated in Chapter 1, this is:

“To examine passenger surface access travel behaviour in order to make recommendations for reducing private vehicle use.”

Preceding chapters established the key surface access issues (Chapter 2) and presented a valuable management perspective on the concepts, implications and future directions of surface access (Chapter 3). Chapter 4 adopted a broader approach, viewing surface access in the wider context of travel behaviour research and placing it within an existing theoretical framework, namely socio-psychological theories of attitude behaviour relations. These preliminary stages enable the appropriate research design and methods to be described in the current chapter.

The research design is discussed in Section 5.2. It acts as a framework for the research; it is a product of the research paradigm, the objectives, and the overall research strategy and informs the data to be collected and how it will be analysed. In this case the data is sourced from a passenger questionnaire survey, which is described in Section 5.3. Methods of data analysis are addressed in Section 5.4. Conclusions are drawn in Section 5.5.

5.2 Research Design

The research design shown in Figure 5.1., determines what type of data will be collected and how it will be analysed. Its fundamental purpose is to provide a structure for fulfilling each of the research objectives and is guided by three main factors, the philosophical positioning of the researcher (or research paradigm), the objectives and research questions, and the research strategy (Oppenheim, 1992). These are discussed in Section 5.2.1, 5.2.2 and 5.2.3, respectively.

5.2.1 Research paradigm

The research paradigm represents the philosophical positioning of the researcher, their beliefs and their view of the world. The concept of research paradigms, which first emerged in the 1960s (Kuhn, 1970), is generally considered to be the foundation on which all research sits. It has been defined as:

> *"a set of basic beliefs (or metaphysics) that deals with ultimates or first principles. It represents a worldview that defines, for its holder, the nature of "the world," the individual's place in it, and the range of possible relationships to that world and its parts..."*

Guba and Lincoln, (1994) p107

To a significant degree the research paradigm determines the type of research methods that are employed. Broadly speaking, research paradigms can be viewed as part of a continuum, with quantitative research methods at one end of the scale,

Aim: To examine passenger surface access travel behaviour in order to make recommendations for reducing private vehicle use.			
Chapter	**Objective**	**Research questions**	**Data**
1			
2	1. To identify key surface access issues.		Literature
3	2. To understand the challenges, implications and future directions of surface access management.	i. How does the nature and scale of surface access issues vary between airports, are some issues unique to particular airports? ii. Are certain strategies considered to be more effective or preferred by airport managers than others? ii. What are the likely future directions of surface access policy?	Interviews
4			
5			
6	3. To assess the personal, situational and spatial characteristics of passenger mode choice.	iv. Do the factors motivating passenger mode choice vary for different modes? v. How are the personal, situational and spatial characteristics of passenger surface access travel expressed in terms of mode choice?	Passenger questionnaire survey
7	4. To evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles.	vi. Are decisions to travel by alternative modes to private vehicles guided predominantly by moral and normative influences or by considerations of personal utility and self-interest? vii. Is a combined theoretical approach more appropriate than either the Norm-Activation Theory or the Theory of Planned Behaviour in their original forms when explaining decisions to travel by alternative modes to airports? viii. Are measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy useful additional predictors of decisions to travel by alternative modes to airports?	
8	5. To determine segments of passengers with the greatest potential to reduce their private vehicle use.	ix. What is the potential of different passenger segments to reduce their private vehicle use?	
9	6. To make recommendations to airport decision makers concerning effective strategies for reducing private vehicle use.		

Figure 5.1 Research design

and qualitative methods at the other. Advocates of purely quantitative methods articulate views that are consistent with what is commonly termed a positivist philosophy (Johnson and Onwuebhuzie, 2004). Positivism maintains that research should place greater emphasis on deductive logic, precision, objectivity and rigour, compared to experience or personal intuition (Collis and Hussey, 2009).

In contrast, supporters of qualitative research methods (also sometimes called constructivists or interpretivists) reject positivist philosophy, contending that multiple constructed realities exist where general inferences are induced from observations of empirical reality (inductive logic). They further argue that research is value-laden and that the researcher is inevitably bound with the researched (Johnson and Onwuebhuzie, 2004).

While quantitative and qualitative 'purists' contend that these two contrasting approaches to research are incompatible (known as the 'incompatibility thesis'), more recently several schools of thought have emerged that acknowledge the value of using a mixed-methods approach (Johnson and Onwuebhuzie, 2004). These newer paradigms, notably pragmatism and postpositivism, sit between the two ends of the paradigm continuum.

Pragmatism represents an alternative approach to research, where the specific methods employed are determined by the nature and needs of the research project (Howe, 1988). Pragmatism tends to lean towards the constructivist perspective in that it recognises the importance of values in research but does not consider them a threat to the validity of the research findings (Cherryholmes, 1992). Further it takes an holistic methodological approach by attempting to obtain and understand findings from both a subjective and objective standstandpoint.

Postpositivism is similar to pragmatism in that it acknowledges that values exist within research, but, in contrast with the latter, postpositivism posits that values can be controlled in a way that ensures the validity of the findings. Similarly, while pragmatism takes a dynamic stance to epistemology (the connection between the researcher and the researched), postpositivism aims to remain objective throughout, whilst acknowledging the fact that external factors do exist. The postpositivist philosophy is further characterised by a largely deductive logic, and an ontological position (the way in which the nature of reality or existence is perceived) that emphasises the existence of a universal reality (Bryman, 2001; Phillips and Burbules, 2000). These characteristics place postpositivism between positivism and pragmatism on the continuum. Figure 5.2 shows a diagrammatic representation of the main research paradigms and their characteristics.

Within these mixed methods approaches different typologies also exist regarding the time-order dimension of different methods (whether qualitative and quantitative methods are used concurrently or sequentially in the research) as well as their relative status (is one approach more dominant than the other, or do both methods carry equal status?)

With this in mind, the philosophy and outlook underpinning this research is most closely related to the postpositivist paradigm. Although the approach employed here is largely quantitative, it is recognised that qualitative techniques are required to gain a deeper understanding of the key surface access issues, as shown in the interviews with airport managers in Chapter 3. Consequently, a mixed-methods, sequential, quantitatively dominant design was considered to be most appropriate for this research.

Positivism	Postpositivism	Pragmatism	Constructivism
Quantitative	Largely quantitative	Mixed methods	Qualitative
Existence of external reality regardless of its understanding	Existence of external reality, but human limitations constrain its understanding	The most suitable 'truth' is dictated by the research	Reality is determined internally by consciousness and interpretation
Deductive	Largely deductive	Deductive or inductive	Inductive
Observed is totally independent from observer	Observer aims to remain independent, but external factors are recognised	No single view, stance can change throughout research	The observer and the observed are inseparable

Sources: Gubba and Lincoln, 1994; Johnson and Onwuebhuzie, 2004; Collis and Hussey, 2009; Howe, 1988; Bryman, 2001; Phillips and Burbules, 2000; Cherryholmes, 1992.

Figure 5.2 The research paradigm continuum

While it is useful to categorise different paradigms and approaches, it is recognised that paradigms are a complex, multi-layered mix of propositions and in reality research does not always fall neatly within predetermined boundaries. It may be the case that the research dictates the use of different approaches, or that specific elements of different paradigms appeal to an individual researcher.

5.2.2 Objectives and research questions

The second factor that drives the research design is the objectives and research questions. These represent prevailing gaps in empirical or theoretical understanding, and the ways in which the research intends to build on original knowledge. As detailed in Figure 5.1, the current research has six objectives (1-6) and nine related research questions (i-ix).

1. To identify key surface access issues.

A review of the literature was undertaken in Chapter 2 to consider the political context from which the surface access problem emerged, as well as providing a description of key issues relating to the varying requirements of airport users, the geographic distribution of airport traffic, commercial pressures, the role of external market conditions, and available management strategies.

2. To understand the challenges, implications and future directions of surface access management.

In Chapter 3, semi-structured interviews were held with key personnel responsible for surface access management at UK airports in order to fulfil the second objective and answer three research questions (i-iii).

> *i. How does the nature and scale of surface access issues vary between UK airports, are some issues unique to particular airports?*
>
> *ii. Are certain strategies considered to be more effective or preferred by airport managers than others?*
>
> *iii. What are the likely future directions of surface access policy?*

3. To assess the personal, situational and spatial characteristics of passenger mode choice.

In Chapter 6 an understanding of the various personal, situational and spatial factors that characterise passenger mode choice is developed using data from the passenger questionnaire survey, which forms the third objective. Two research questions (iv-v) arising from the literature review and interviews with airport managers (see Section 3.4) are also addressed.

iv. Do the factors motivating passenger mode choice vary for different modes?

v. How are the personal, situational and spatial characteristics of passenger surface access travel expressed in terms of mode choice?

4. To evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles.

Given the need to address the attitudinal and psychological antecedents of surface access travel behaviour, in Chapter 7 two social psychological theories of attitude behaviour relations, the Norm-Activation Theory and the Theory of Planned Behaviour, are used to evaluate the psychological factors governing decisions to use alternative modes to private vehicles. This forms the fourth objective. Three research questions (vi-viii) are also addressed.

vi. Are decisions to travel by alternative modes to private vehicles guided predominantly by moral and normative influences or by considerations of personal utility and self-interest?

vii. Is a combined theoretical approach more appropriate than either the Theory of Planned Behaviour or the Norm-Activation Theory in their original forms when explaining decisions to travel by alternative modes to airports?

viii. Are measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy useful additional predictors of decisions to travel by alternative modes to airports?

5. To determine segments of passengers with the greatest potential to reduce their private vehicle use.

Given that policies are considered most effective when they are targeted at specific groups or market segments (Stradling et al., 2000; Anable, 2005), in Chapter 8 market segmentation is used to identify groups of passengers with the potential to reduce their private vehicle use. This forms the fifth objective and also addresses the final research question (ix).

ix. *What is the potential of different passenger segments to reduce their private vehicle use?*

6. To make recommendations to airport decision makers concerning effective strategies for reducing private vehicle use.

The findings from the analysis then form the basis for a number of policy recommendations to airport decision makers, which forms the sixth objective and is detailed in Chapter 9.

5.2.3 Research strategy

The third factor that influences the research design is the research strategy, which can be considered as a systematic plan of action for carrying out the research. While the research paradigm influences the *type* of methods that are used (quantitative, qualitative or mixed-methods), the research strategy determines the *actual* methods that are used.

In turn, the choice of research strategy is determined by three factors; the nature of the questions under study, the level of control exercised by the researcher over the phenomena being studied, and whether the research is focused on contemporary or historical events (Yin, 2009). To a degree, the research strategy is also influenced by the research paradigm, as different approaches tend to lend themselves to particular research strategies.

As the research is concerned with contemporary events, research strategies such as archival studies or historical analyses could immediately be discounted. Similarly, an experimental approach was discounted since it requires the researcher to have full control over the events in the study so that elements can be altered and re-tested to measure changes in results (Yin, 2009). Such an approach was clearly unworkable in the present context.

A survey was considered to be the most suitable approach for a number of reasons. A particular strength of surveys is that they can be used to highlight the distribution of characteristics within a population, between sites or amongst different sub-groups within a population. This was an attractive proposition here given that a key component of the research involves assessing variations in travel behaviour.

Furthermore, the theoretical underpinning of the research relates to the Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991). A review of similar studies using this approach, which are discussed in the previous chapter, reveal that they have almost universally collected the relevant data via attitude statements included in questionnaire surveys. Properly conducted surveys can present findings that are statistically valid for a defined population, and as such allow for meaningful conclusions to be drawn (Secor, 2010).

5.3 Passenger Questionnaire Survey

This section describes the passenger questionnaire survey which informs the present research. The selection of the study airport is addressed in Section 5.3.1. The survey format, structure and sample are discussed in Sections 5.3.2, 5.3.3 and 5.3.4, respectively. The pilot stage of the survey is described in Section 5.3.5, and the main data collection phase is detailed in Section 5.3.6. Section 5.3.7 then considers the response rate of the survey.

5.3.1 Study airport

Initially, it was important to consider carefully which airport would form the most appropriate base for the proposed study. As discussed in Section 3.4, a key issue arising from the literature and interviews with airport managers relates to problems of traffic congestion at large airports caused by high private vehicle use. These problems are exacerbated by the high volumes of passenger drop-off/pick-up journeys. It is generally recognised that there is a need to develop strategies that reduce the share of private vehicle journeys and drop-off/pick-up in particular. The criteria for selection of the study airport were therefore twofold; it should be a large airport (>10 million passengers) and have existing problems of high private vehicle access and drop-off/pick-up journeys.

Using the classification of airport size provided by Humphreys and Ison (2005), four large airports (>10 million annual passengers) were identified using data from the CAA Passenger Survey Report for 2009; Heathrow (65.9m passengers), Gatwick (32.4m passengers), Stansted (19.9m passengers) and Manchester (18.6m passengers) (CAA, 2010).

The share of passenger journeys by private vehicles (car and drop-off + rental car + taxi) was then assessed for each of these airports. Of the four airports, Manchester had by far the highest relative overall share of private vehicle journeys (86.8%), followed by Gatwick Airport (62.1%), Heathrow Airport (59.5%), and Stansted Airport (52.2%). Given that Manchester's overall mode share of private vehicle trips was nearly 25% higher than the airport with the second highest private vehicle mode share it was selected as the study airport.

Manchester Airport, located in the north-west of England, handled 18.7m passengers in 2011 (CAA, 2012). It has three passenger terminals and two runways. Around 60 airlines serve over 200 domestic and international destinations from the airport. Approximately 19,000 people are employed at the airport either directly or indirectly, making it one of the major employment centres in the region (Manchester Airports Group, 2012).

The airport is situated to the south of Manchester, and is now well connected to the UK national motorway network, near a confluence of the M6 which runs north-south, M56 and the M60 which runs east-west. It is also well connected to the national rail network with its own railway station, and services operating between the airport and much of England via the West Coast Mainline and Trans-Pennine Line, respectively. There are also various local and regional bus services operating to the airport. Public transport operations are integrated at the airport in a single hub complex called 'The Station', located at the centre of the airport site and connected to Terminals 1 and 2 by means of enclosed elevated walkways.

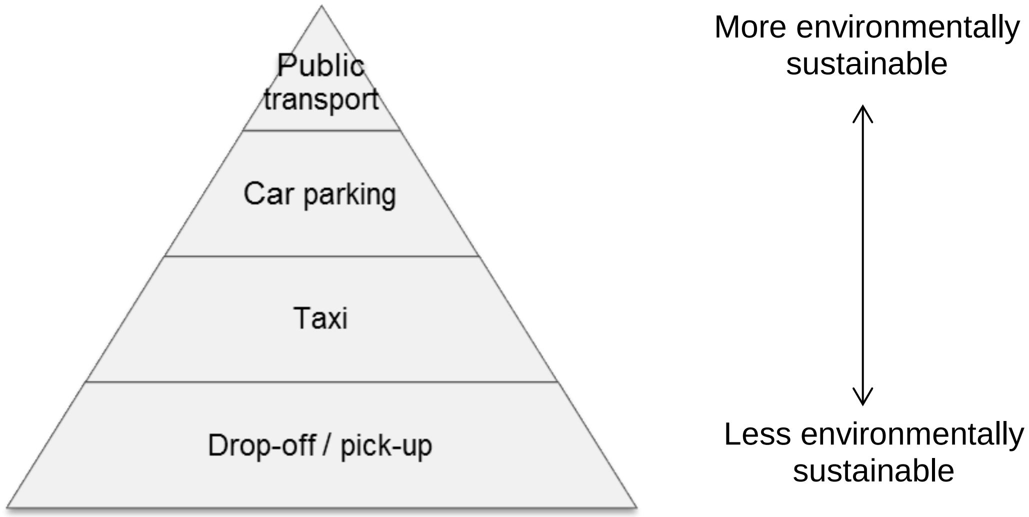
As part of the airport's commitment to its Airport Surface Access Strategy (ASAS) the airport has on-going targets for increasing the overall share of public transport journeys by passengers to 26-28% by 2015, and a longer term ambition to achieve 40% of passengers travelling by public transport (Manchester Airport, 2007). The scale of this task is demonstrated by the fact that in 2009 only 13% of passenger journeys were made using public transport (CAA, 2010).

Recognising that achieving incremental behavioural change is often more realistic than large step changes, Manchester Airport detail a 'Hierarchy of Preferred Transport Choices' (Figure 5.3). Strategies are designed to 'push' people away from more environmentally damaging modes such as drop-off/pick-up and taxi in favour of using less intensive modes such as car parking, and, ultimately, public transport.

Initiating behavioural change is identified as a key component of surface access strategy development.

> "*Changing behaviour lies at the heart of our strategy and is the main focus of our objective to reduce the dependence on the private car.*"
>
> Manchester Airport, 2007, p33

On-going surface access projects at the airport include the extension of the Manchester Metrolink light rail system to the airport, which is expected to open in 2016, and continued investment in public transport provision (Manchester Airport, 2007).



Source: Adapted from Manchester Airport, 2007, p6

Figure 5.3 Hierarchy of Preferred Modes

5.3.2 Survey format

A variety of different survey format options exist to collect the relevant data. The choice of which method to use is governed by a number of factors including issues of data quality, the appropriateness of the medium to the questions, sampling considerations and cost issues (Dykema et al 2008; Brace, 2008). Broadly speaking, surveys can be divided into two main categories; interviewer administered and self-completion surveys (Brace, 2008). Interviewer administered surveys include face-to-face, computer assisted (CAPI) and telephone interviews, while self-completed surveys can be paper based questionnaires or web based surveys. These methods are shown in Table 5.1, along with their associated advantages and disadvantages.

An advantage of interviewer administered surveys is that queries or misunderstandings can be dealt with quickly. Interviewers can also encourage respondents to clarify answers or provide deeper responses to questions where necessary (Brace, 2008). This is not possible in self-completion surveys like paper based questionnaires. Given these limitations, an interviewer administered survey was considered to be the most suitable approach for the present research.

Face-to-face interviews are a commonly employed interviewer administered survey technique, and generally involve the completion of a questionnaire survey. One of their main advantages is that they typically yield higher response rates than other methods (Hox and Leeuw, 1994). While a high response rate is important for most surveys, it is especially important here given the time and financial resources available, and the need to gather a sufficiently large sample to permit valid statistical analysis. Face-to-face interviews allow for complex material to be included in the questionnaire, as interviewers are present to clarify any misunderstandings (Dyker et al., 2008). This was a key consideration here given the need to include potentially complex attitudinal statements. Face-to-face interviews also allow interviewers to screen and select respondents to suit the sampling strategy. Visual information such as show cards or prompts can also be used in a face-to-face interview, unlike other methods like telephone surveys.

Table 5.1 Comparison of survey methods

	Method	Advantages	Disadvantages
Interviewer administered	Face-to-Face interviews	High response rate Complex questioning Screening of respondents Ability to show visual Information	Expensive Possible measurement error/bias Social desirability bias
	Computer aided personal interviews (CAPI)	All the benefits of face-to-face interviews No post survey data entry needed Complex routing of questions Identify trends and patterns	Expensive Requires training
	Telephone interviews	Time and cost efficient Geographical coverage Respondent anonymity	Limited length and complexity of survey Hard to covey visual information Sampling issues
Self-completed	Paper based questionnaires	Respondents can complete questionnaires in their own time Descriptive/illustrative material easily included	Long time to administer Interviewers cannot deal with misunderstandings or ensure completion Relatively low response rate
	Web based surveys	All the benefits of paper based questionnaires Question routing Relatively cheap	Excludes people without internet access

Sources: Hox and Leeuw, 1994; O'Reilly et al. 1994; Brace, 2008; Dillman and Parsons, 2008; Dyker et al. 2008; Lavrakas, 2008; Vehovar et al. 2008.

Arguably, the main disadvantage of face-to-face interviews is that they are typically more expensive than other methods, and require a longer fieldwork period. Face-to-face interviews may also suffer from errors and/or bias introduced either via the interviewer or respondent. For example, respondents may over report desirable behaviour and under report undesirable behaviour in order to present themselves in a positive light, a phenomenon known as social desirability bias (Belli et al., 1999).

Compared with other survey methods, face-to-interviews fulfilled a number of important criteria for the research, namely the need for a high response rate, to include complex questioning (in the form of attitudinal statements), and the ability of the interviewers to screen participants and clarify any misunderstandings about the survey. The following section, 5.3.3, describes the structure of the questionnaire.

5.3.3 Questionnaire structure

The questionnaire was divided into six main sections (A to F), and consisted predominantly of closed questions and scaled responses in order to gain information on specific issues and to allow for comparisons to be made between the data. A summary of the survey is shown in Table 5.2. A copy of the full questionnaire schedule is provided in Appendix B.

Table 5.2 Questionnaire structure

Section	Questions	Description
A *Surface access trip*	1-9	Origin type and location; mode choice and reasons for choosing it; approx. journey time; journey satisfaction; leg of air trip; egress mode choice (if on the outbound leg of trip); general mobility behaviour.
B *Flight*	10-19	Destination airport; flight number and departure time; trip purpose; duration of trip; travel group size; presence of young or limited mobility passengers in group; items of luggage; reasons for choosing to fly from Manchester Airport; general use of air travel in the previous 12 months.
C *Attitude statements1*	20-23	Attitude statements from the Norm-Activation Theory (general problem awareness, awareness of consequences, personal norm) and three additional factors (efficacy, descriptive norm, perceived guilt; car access.
D *Attitude statements2*	24-29	Attitude statements from the Theory of Planned Behaviour (attitude, subjective norm, perceived behavioural control, intention); one additional statement for personal norm.
E *Ride sharing*	30-32	Stated propensity to share rides with other passengers and the reasons behind this; general comments.
F *Socio-demographic information*	33-35	Country of residence; nationality; age; gender.

A ‘screening’ question was included at the start of the questionnaire to ensure that only passengers who had travelled to Manchester Airport by surface transportation on the day of the survey (i.e. not passengers who were connecting from another flight) were included.

Questions in Section A were designed to elicit information about the passenger’s surface access trip. As this data was of key importance for the analysis it was placed at the start of the questionnaire to ensure a high response rate and to negate the possible negative effects of respondent fatigue later on in the questionnaire (Brace, 2008). Following this, Section B included questions about the passenger's flight. This information was used to assess the situational characteristics of passenger mode choice. Two open ended questions were also included in Sections A and B asking respondents to provide the reasons why they had chosen a certain mode and why they had flown from Manchester Airport. Responses to the former were used to explore the general factors motivating mode choice decisions (see Section 5.4.1). Open ended questions can often reveal additional information or motivations that were perhaps unexpected, and which may have been missed via closed questioning (Frazer and Lawley, 2000).

In Section C attitudinal statements pertaining to psychological constructs from the Norm-Activation Theory and three additional psychological constructs were included. This information was included to evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles and help form the basis of the cluster analysis procedure. Attitudinal statements were measured on a 5 point Likert scale (Strongly agree = 5, Strongly disagree = 1), with higher scores representing more favourable responses. Likert scales are commonly favoured inattitudinal research as they are easier to use in a survey setting than other scales (for example, paired-comparison techniques or Thurstone scales) and "…*tend to perform very well when it comes to a reliable, rough ordering of people with regard to a particular attitude* (Oppenheim, 1992, p194). Some items were negatively worded to avoid respondent acquiescence, where respondents fall into a pattern of continually agreeing with statements either through fatigue or due to perceived social desirability (Oppenheim, 1992). These items were subsequently reverse coded for analysis. Attitudinal statements were carefully worded to reflect similar measures used in previous travel behaviour studies (for example, see Bamberg et al, 2003, Nordlund and Garvill, 2003). One question was also included to assess whether the respondent had regular access to a car in the UK (either as a driver or passenger).

Attitudinal statements in Section D were included to measure constructs from the Theory of Planned Behaviour. Since the Theory of Planned Behaviour is concerned with predicting future behaviour, respondents were asked to imagine that they were taking the same trip again at some point in the coming year. One additional question relating to personal norm was also included. Again, statements were measured on a 5 point Likert scale. Like the previous section, information from Section D was required for evaluating the psychological factors governing behaviour.

Section E was designed to assess the likelihood of passengers choosing to share a ride to the airport. These items were included as part of a separate research project and subsequently are not analysed here. Finally, socio-demographic information was elicited in Section F, and was required to assess the personal characteristics of mode choice, which is addressed in the following chapter. The next section describes the survey sample.

5.3.4 Defining the survey sample

A key consideration when defining the sample size was the need to collect sufficient data to perform a cluster analysis procedure, which is used as the market segmentation technique in Chapter 8. While it is possible to perform a cluster analysis with only a relatively small number of cases, with smaller sample sizes findings become increasingly susceptible to the effect of outliers in the data. Unfortunately, there is no general consensus regarding the minimum sample size required to perform a cluster analysis, although Hair et al. (2005), suggest that it should not be below 100 cases. They also cite research by Formann (1984) that recommends that to perform a cluster analysis sample sizes should be greater than 2^m, where *m* is the number of variables included in the procedure. With this in mind, and considering the available resources for the research, a minimum sample size of 500 was targeted.

As the research concerns passenger surface access travel, other surface access users (such as employees) were omitted from the sample. Departing passengers were selected as the focus of the survey. While surface access travel includes both trips to and from the airport, studies have typically focused on the former (Gosling, 2008). This is largely because departing passengers are easier to survey than arriving passengers, who are more likely to be tired after their flight and wishing to go home or on to their destination. Passengers under 18 years of age were also omitted from the survey as it was assumed that they would be travelling with adults who would be responsible for decisions about surface access travel.

5.3.5 Piloting the questionnaire

In order to ensure that the questionnaire structure and individual items were appropriate for the research a pilot survey was conducted. The pilot of the questionnaire took place at Manchester Airport between 12-20th May, 2011. For this a commercial market research company, KGS, were commissioned to help administer the questionnaire. The company was selected since they had significant experience of administering surveys in an airport setting. Their professional association with Manchester Airport also enabled them to organise security clearance for the researcher to work at the airport. Questionnaires were conducted in the departure lounges of each of the airport's three terminals, and interviewer shifts (each lasting 6 hours) were organised to include morning, afternoon and evening periods as well as week days and weekends. The size of the pilot survey was intended to represent around 10% of the total intended sample size of the main survey (500). Overall, 62 questionnaires were conducted in the pilot stage of the survey.

On the first day of the pilot survey, data collection was actively monitored by the researcher. Feedback was sought from both respondents and interviewers about any issues or difficulties they had experienced completing the questionnaire. This feedback proved very useful in helping to improve the questionnaire. For example, several respondents commented that some questions had too many response options, and that the wording of some of the attitudinal statements was confusing. Further feedback and recommendations were provided by KGS after completion of the pilot survey. A number of amendments to question wording and format were subsequently made to the questionnaire before the main data collection phase.

Throughout the pilot and main data collection phase of the questionnaire, care was taken to ensure adherence to Loughborough University's code of practice regarding research with human participants. Participants were asked to provide their informed consent to take part in the survey once the nature and purpose of the questionnaire had been explained to them. Participants were assured of their anonymity and informed that they were free to withdraw from the questionnaire at any time. All completed questionnaires were then kept in a locked room at the airport which was accessible only by KGS employees. At the end of the survey period completed questionnaires were sent to the researcher by recorded courier.

5.3.6 Conducting the questionnaire

The main questionnaire was administered during a six week period between June 13th and July 23rd, 2011. Again, KGS were commissioned to help with the administration. Each questionnaire took about 15 minutes to complete, and 860 questionnaires were conducted before the end of the survey period.

Questionnaires were conducted in the departure hall of each terminal. The researcher(s) would select an area (normally a seating area) and approach passengers within it and ask them if they would be willing to take part in the questionnaire. People obviously wearing airport uniforms and/or an airport security lanyard were deliberately avoided so as not to include airport employees in the survey. After the survey was completed, or if the passenger refused to take part in the questionnaire, the interviewer would select a different area in the departures hall and start again. On the advice of KGS, passengers were not approached in shops or cafes since their experience suggested that passengers are less willing to take part in surveys in these environments. Passengers obviously under the age of 18 were also avoided for the reason outlined in Section 5.3.4.

Data collection was spread over 50 shifts, each lasting six hours. To ensure that a range of time periods were covered, 25 shifts were scheduled during the morning (06:00 to 12:00), and 23 shifts were arranged for the afternoon/evening (12:00 to 18:00). In addition, two later shifts were also scheduled (14:00 to 20:00) to capture later flights. Shifts were arranged for both week days and weekends in order to include different days of the week and thus capture the widest range of destinations and travellers possible. In some instances a morning and an afternoon shift were arranged for the same day, again to try and capture a wide range of flights and to provide as representative a sample as possible.

To ensure that the sample was representative of the airport as a whole, shifts were allocated according to the distribution of passengers between the three terminals. In 2010, Terminal 1 handled 48% of all passengers at the airport, while Terminal 2 and 3 accounted for 28% and 24% of all passengers, respectively (CAA, 2011). As a result 24 shifts (nearly half) were allocated to Terminal 1, while 13 shifts were allocated to Terminals 2 and 3.

Quotas were also implemented to reflect the passenger mix in each terminal based on up to date CAA data, which was kindly made available by the airport operator at the researcher's request. For example, Terminal 2 is characterised by having a greater share of long haul traffic and is commonly used more by leisure passengers. In contrast, Terminal 3 predominantly handles short haul or domestic traffic and has a greater share of business passengers. Survey quotas were subsequently formed to reflect these differences in the data collection phase. The quotas for each terminal are provided in Appendix C. The researcher spent two weeks at the airport from June 20-24 and July 4-8, 2011 both to monitor and actively participate in the data collection.

5.3.7 Survey response

In total 860 surveys were collected, more than originally anticipated and well in excess of the 500 questionnaires which was originally calculated as being necessary for the analysis. Pleasingly, there were very few spoiled or unfinished questionnaires.

Furthermore, the majority of passengers (*n*= 583, 67.8%) provided a full UK postcode for the origin of their surface access trip. This was unexpected as it was anticipated that some passengers would either not know the postcode of their trip origin (especially if they were not travelling from their home), or would choose not to provide it owing to concerns that they would be contacted again or have their details passed on to a third party, despite assurances of confidentiality.

Having obtained the data, it is necessary to consider how it needs to be analysed in line with the research objectives outlined in Chapter 1 and Section 5.2.2.

5.4 Research methods

This section describes the research methods used to analyse the survey data. Discussions concerning the appropriateness of each method for the research, the units of analysis and how each method was conducted are provided

5.4.1 Descriptive statistics and GIS mapping

Analysis in Chapter 6 relates to the third objective, "to assess the personal, situational and spatial characteristics of passenger mode choice." The chapter also addresses two research questions (iv-v).

Initially, analysis seeks to determine whether "*the factors motivating passenger mode choice vary for different modes (research question iv)."* Ashford et al. (2013) state that, broadly speaking, passenger mode choice is a function of individual perceptions concerning the relative cost, comfort and convenience of different modes. This view is supported by Psaraki and Abacoumkin (2002), Pels et al. (2003), and Tam et al. (2010). However, as shown in Chapter 3 (Section 3.4), there remains a need to better understand how the relative role of these factors varies between modes, and whether certain modes are more or less associated with different factors than others. Such insights will aid more informed decision making.

While it is relatively straightforward to measure passenger perceptions of comfort and convenience (for example, via ratings of different service attributes as used by Tam et al., 2010) or their ranked preferences for certain characteristics, assessing the role of cost considerations is much more difficult. It is therefore important to consider how best to account for the role of cost in the research.

As discussed in Section 4.2, econometric approaches to travel behaviour have generally employed modelling techniques such as multinomial logit or nested logit models (Gosling, 2008). One of the earliest models was developed by Harvey (1986), who used a nested logit model to model passenger mode choice in the San Francisco Bay Area region. Similar models have also been developed by Pels et al. (2003) and Psaraki and Abacoumkin (2002) in a surface access context. However, a choice modelling approach such as this was not considered to be the most appropriate method for this research for both theoretical and practical reasons. The need to examine the attitudinal, behavioural, aspects of travel behaviour was identified as key area for further research in the interviews with airport managers (Section 3.4). As outlined in Section 4.2, socio-psychological approaches to travel behaviour, exemplified by theories such as the Norm-Activation Theory and the Theory of Planned Behaviour, represent a departure from the traditional econometric approach to travel behaviour research (Heath and Gifford, 2002). For example, it is notable that travel behaviour studies that employ the Norm-Activation Theory and the Theory of Planned Behaviour seldom, if ever, include an explicit measure of cost as an explanatory variable of behaviour (for example, see Bamberg and Schmidt, 2003; Bamberg et al., 2007; Nordlund and Garvill, 2003).

Practical considerations also dictate the method eventually adopted. Assessing the *true* financial cost of surface access travel journeys, as well as how people perceive these costs, is a complex process. For example, being dropped-off/picked-up at the airport is generally regarded as being ‘free’ by the end user, although this is clearly not the case when petrol, maintenance and insurance costs of the vehicle and the time expended by the driver are taken into account. Similarly, passengers who park at the airport may only take into consideration the cost of their car parking, rather than the petrol and associated costs of using their vehicle to travel to the airport. Further issues also exist, such as determining who actually pays for the incurred travel costs. For example, a passenger may be travelling as part of a couple where the whole or part of their travel is paid for by their partner, or even in some cases, their partner’s workplace. In order to account for the role of cost considerations properly it would be necessary to fully address these issues.

Furthermore, econometric approaches such as those employed by Pels et al. (2003), typically require a considerable amount of data to be collected. In order to justify such an approach it would inevitably mean devoting a significant share of the survey to this purpose. Given the time and space constraints of the questionnaire and the desire to prioritise the attitudinal statements and collect other relevant data, a pragmatic decision was made to focus on the attitudinal and socio-psychological outputs of the survey. Motivational factors influencing modes choice were subsequently determined using responses to an open ended question in the questionnaire which, as described in Section 5.3.3, asked respondents to explain the reasons why they had chosen to travel to the airport in the way that they had.

The chapter then addresses *“how the personal, situational and spatial characteristics of passenger surface access travel are expressed in terms of mode choice (research question v).”* To achieve this, simple statistical techniques such as counts and percentages are used to show the overall distribution of the data in terms of passenger’s personal and situational characteristics. Additionally, commercially available GIS mapping software is employed to map passenger journey origins and assess the spatial characteristics of mode choice. In combination, this information is then used to develop a typology of surface access passengers, which is described in the following section.

5.4.2 Multinomial logistic regression

Using the personal, situational, and spatial data derived from the analysis described in the previous section (Section 5.4.1), multinomial logistic regression is used to develop a typology of surface access passengers. As noted by Smith (2002, p381), typologies are useful in a policy context because they *“… create useful heuristics and provide a systematic basis for comparison,”* thus making it a suitable approach for the current research.

Multinomial logistic regression is a form of multiple regression, and can be considered as an extension of logistic regression (Moutinho and Hutcheson, 2011). It identifies the variables that collectively distinguish cases belonging to different categories of an unordered nominal (or categorical) dependent variable (Howitt and Cramer, 2011). Multinomial logistic regression differs from other types of regression in that instead of the independent (or explanatory) variables predicting scores on the dependent variable, they predict group membership. It is a technique that is commonly used in travel behaviour research and mode choice (for example, Black, 2001; Schwanen et al, 2001; Ewing et al, 2004; Muller, 2008). The general multinomial logistic regression model can be defined as:

$$\log \frac{\Pr(Y = j)}{\Pr(Y = j')} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k$$

where:

$Pr(Y)$	is the probability that event Y is chosen
j	is the identified category
j'	is the reference category
α	is the constant term
β	is the coefficient of the independent variable
X	is the independent variable
k	is the number of variables

Source: Moutinho and Hutcheson, 2011

The procedure assess the relative utility a person assigns to a set of discrete choices. Alternatives with a greater utility assigned to them are more likely to be chosen. The utility of an alternative consists of a deterministic part, which incorporates the observed and measured variables, and an error term, which accounts for the unexplained variance in utility (Gosling, 2008). The deterministic part of the utility is a function of the independent variables and their model coefficients, which are estimated in the modelling process. In multinomial logistic regression, independent variables can be score variables, nominal (category) variables or a mixture of the two (Howitt and Cramer, 2011).

Although utility is an abstract construct that cannot be measured directly, if an alternative is chosen then it is considered that the utility derived from that choice exceeds the other alternatives. The role of the independent variables in this can be derived by comparing the standardised regression coefficients (β) of the independent variables. These essentially indicate how many standard deviation units the dependent variable will change for one standard deviation unit change in the independent variable (Bryman and Cramer, 1997).

This enables predictions to be made about the probability of choosing a given alternative. Based on their underlying characteristics for the independent variables, statistical software packages (such as SPSS) can be used to calculate the probability of a person choosing each alternative. Where the *predicted* number of cases for each alternative corresponds closely with the *actual* number of cases for each alternative, the model is considered to be a good fit with the data (Moutinho and Hutcheson, 2011).

In multinomial logistic regression Pseudo R-Square statistics are also calculated as part of the output from the procedure. These are analogous to R-Square statistics in multiple regression, in that they indicate the combined relationship of the independent variables with the dependent variable (Howitt and Cramer, 2011). Using SPSS, three Pseudo R-Statistics are routinely reported; Cox and Snell, Nagelkerke, and McFadden. As a rule of thumb, values of around 0.4 for Cox and Snell and Nakelkerke, and between 0.2 and 0.4 for McFadden, are considered indicative of a well-fitting model (Howitt and Cramer, 2011; McFadden, 1973).

5.4.3 Structural Equation Modelling

Analysis in Chapter 7 relates to the fourth objective, "to evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles." For this, structural equation modelling is used to test the predictive ability of the Norm-Activation Theory (Schwartz, 1977), the Theory of Planned Behaviour (Ajzen, 1991), and two combined models in the context of public transport use by passengers in the survey. Tests of the Norm-Activation Theory and the Theory of Planned Behaviour seek to establish whether *"decisions to travel by alternative modes to private vehicles are guided predominantly by moral and normative influences or by considerations of personal utility and self-interest (research question vi)."* Tests of the combined models, on the other hand, address whether *"a combined theoretical approach is more appropriate than either the Theory of Planned Behaviour or the Norm-Activation Theory in their original forms (research question vii),"* and determine if *"measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy are useful additional predictors of decisions to travel by alternative modes to airports (research question viii)."*

Structural equation modelling is a highly flexible multivariate statistical modelling technique. Rather than an individual type of test or technique, it represents an approach to data analysis that incorporates a variety of multivariate statistical techniques such as multiple regression, simultaneous equations and factor analysis (Howitt and Cramer, 2011). Structural equation modelling is a confirmatory, rather than an exploratory, method as it is used to test the validity of a hypothesised theoretical model (Golob, 2003). The process simultaneously tests the extent to which the causal processes posited by a model are consistent with the data. If the overall ‘fit’ of the model with the data is acceptable then the postulated relationships (and thus the model overall) are accepted, if the fit is not acceptable, then the model is rejected (Byrne, 2012).

A key advantage of structural equation modelling is that it can deal with latent (or unobserved) variables. As Byrne (2012, p4), notes *“In the behavioural sciences, researchers are often interested in studying theoretical constructs that cannot be observed directly.”* This makes structural equation modelling well suited to testing psychological behavioural theories, such as the Norm-Activation Theory and the Theory of Planned Behaviour.

A structural equation model is composed of two main elements; a measurement model (or sub-model) and a structural model. The measurement (sub)model is a multivariate regression model that describes the relationships between a set of observed dependent variables and a set of continuous latent variables (Muthén and Muthén, 2010). Typically, this refers to the association between some form of unobservable latent construct, such as attitude, and the observable factors used to measure it (for example, items in a questionnaire). In this sense the measurement model is similar to a confirmatory factor analysis. Generally the measurement model is not reported in the research, but in some instances may be included to clarify the appropriateness of the data or some particular aspect of the model (Golob, 2003).

The structural model, as the name implies, is *the* key element of structural equation modelling. It describes the degree to which latent variables directly or indirectly influence changes in the values of other variables in the model. An important distinction here relates to the difference between direct and total effects (Golob, 2003). Direct effects represent the degree to which one variable directly impacts, or ‘causes’, the other (Byrne, 2012). These relationships are commonly expressed as standardised path coefficients (β), and represent the direct effect subjective norm has on intention in the Theory of Planned Behaviour, for example. Effects are commonly interpreted in relation to Cohen’s (1988) guidelines:

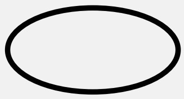
≥0.10 - <0.30 represents a small effect

≥0.30 - <0.50 represents a medium sized effect

≥0.50 represents a large effect

Total effects, on the other hand, represent the sum of all the direct and indirect effects acting on a variable (Golob, 2003). The indirect effects include all intervening variables along a particular path in a model. This is commonly referred to as the explained variance (R^2), and represents the proportion of variance that can be explained in a variable by its related constructs. Essentially, it shows to what extent the changes in one variable are the result of changes in other variables in the model, and not some external influence. For example, in the Theory of Planned Behaviour the total effect of attitude, subjective norm and perceived behavioural control on intention is calculated. While structural equation models can be represented by a series of equations, for ease of interpretation they are most commonly displayed schematically. Table 5.3 represents the symbol notion for a structural equation model.

Table 5.3 Symbol notation in structural equation modelling

Symbol	Description
	Latent or unobserved variable, such as a psychological construct
	Observed or measurable variable, such as an item in a survey or the behaviour being measured.
	Regression coefficient indicating the impact of one variable on another.
	Covariance or correlations between pairs of variables.

Source: Adapted from Byrne, 2012.

When formulating a structural equation model it is important to designate an estimation method. The purpose of this process is to ensure, as much as possible, that the estimated covariance matrix of the model and the data are zero. The choice of estimation procedure can impact upon the overall assessment of the model. The most commonly used estimation methods are normal-theory (ML), generalized least squares (GLS) and weighted least squares (WLS) (Golob, 2003).

Typically, dependent variables in structural equation models will be continuous variables (for example, scores or ratings). In recent years, however, it has become more common for categorical dependent variables to be used. This has had clear benefits for the application of structural equation modelling in a transport context given that mode choice, for example, is a categorical variable. As acknowledged by Byrne (2012), it is only in the last decade or so that researchers using structural equation modelling have been able to use categorical dependent variables, as the processes involved is more complex than for continuous variables. Previously, categorical variables were simply treated as continuous variables, although, as

Powers and Xie (2008) note, this can lead to significant problems in the estimation process. For example, if categorical dependent variables are treated as continuous dependent variables, predicted values can fall outside the expected range on the dependent variable. In contrast, the distinction is of only minor significance when dealing with independent variables (ibid, 2008).

To address this issue, Muthén and Muthén (2010), and Byrne (2012), suggest that when the use of a categorical dependent variable is unavoidable it is best to keep the number of categories to a minimum because the process and interpretation becomes more complex as the number of categories on the dependent variable increases. In terms of the model estimation method, Muthén and Muthén (2010) also suggest using a robust weighted least squares approach (WLS).

The overall aim of structural equation modelling is to determine how well a hypothesized model 'fits' the data. Many different criteria have been developed to assess model fit, with most being based to some degree on chi-square. A well-fitting model is considered to be one where chi-square is non-significant, given that it measures the difference between the observed covariance matrix in the data and the one in the model, which should ideally be zero (Golob, 2003). Other goodness-of-fit statistics commonly reported in structural equation modelling research are Root Mean Square Error of Approximation (RMSEA), Confirmatory Fix Index (CFI), Tucker-Lewis Index (TLI), and Weighted Root Mean Square Residual (WRMR) (Byrne, 2012). As a rule of thumb, the value of RMSEA for a good fitting model should be <0.05, although it is noted that this can increase with model complexity (MacCallum et al, 1996). Values >0.90 for CFI and TLI are considered representative of a well-fitting model (Byrne, 2012), whereas WRMR values should be >0.50 (Muthén and Muthén, 2010).

The use of structural equation modelling in travel behaviour research dates to the early 1980s, when Den Boon (1980) first applied it in the context of a joint model of vehicle ownership and usage in the Netherlands. It has since been applied in a wide range of travel behaviour domains including travel demand modelling, organisational behaviour and values, and driver behaviour (see Golob, 2003 for a review). An early application of structural equation modelling in the context of attitudes and mode choice is provided by Lyon (1984), who examined the dynamic nature of attitude-behaviour relations for travel behaviour among citizens in the United States. More recently, Gärling et al (2001), investigated the links between attitudes to driving and the propensity for these attitudes to cause travel decisions to be more automatically invoked. Using a relatively small sample of drivers in Sweden (*n=60*), they found that more positive attitudes towards driving lead to increased frequency of car use, which in turn lead to more automatic or habitual decision making.

Structural equation modelling has also been used in the context of surface access travel. Tam et al. (2010) employed the latent variable ‘satisfaction’ (composed of passenger service quality perceptions), in the context of passenger mode choice among a sample of 994 respondents at Hong Kong International Airport. As expected, passengers were more likely to choose a mode they perceived to have higher levels of service provision.

5.4.4 Factor Analysis and Cluster Analysis

Analysis in Chapter 8 seeks "to determine segments of passengers with the greatest potential to reduce their private vehicle use (objective 5)." To fulfil this objective, both factor and cluster analysis are used.

Factor analysis is a well-established multivariate technique that broadly aims to explain a number of measurements or observations in terms of a smaller number of unobservable (latent) factors (Dugard et al., 2010). It helps identify an underlying structure among the variables in the analysis by identifying correlations and relationships within the data

"Broadly speaking, factor analysis provides the tools for analysing the structure of the interrelationships (correlations) among a large number of variables by defining sets of variables that are highly correlated, known as factors."

Hair et al. 2005, p104

There are two broad categories of factors analysis: exploratory and confirmatory (Howitt and Cramer, 2011). Exploratory factor analysis is used when the researcher is concerned with describing a large number of variables in terms of a smaller number of underlying latent factors. The researcher will typically not have made any preconceptions about the nature or number of factors that describe the data (Dugard et al., 2010). Confirmatory factor analysis, on the other hand, may be used when the researcher already has some preconceived notion of the underlying structure of the data based on theory or prior research (Hair et al., 2005). The process of conducting a factor analysis in software such as SPSS involves four key stages, which are summarised in Table 5.4.

Table 5.4 Stages in conducting a factor analysis

	Step	Description
1	Calculation of correlation matrix	A correlation matrix is created showing how each variable (measure) is correlated with each of the other variables. This is usually achieved with the aid of computer software such as SPSS
2	Extraction of factors	The combination of variables whose shared correlations explain the largest amount of total variance are selected. This process is then repeated for each combination of variables that in turn explain the greatest amount of remaining variance until a certain number of factors are created. Eigenvalues for each factor are also calculated. These indicate the proportion of variance each factor is accountable for. Typically, only factors with an Eigenvalue of >1 are used, which can be represented graphically on a Scree Plot. There are two main methods of extraction; Principal Components and Principal Axis Factoring.
3	Factor rotation	Once the number of factors has been chosen the results are rotated to ease interpretation. The goal of rotation is to create a simple structure, with variables loading highly on one factor and low on all other factors. Factor loadings vary between 0-1, and indicate the strength of association between a variable and a factor. There are two main types of factor rotation; orthogonal (varimax) rotation, which assumes no correlation between factors, and oblique rotation, which assumes a certain level of correlation between factors.
4	Interpretation	Consideration of factors and the variables that load on them. Often a name will be given to each factor describing the collection of variables that load on it.

Sources: George and Mallery, 2007; Howitt and Cramer, 2011.

In Chapter 8 an exploratory factor analysis is used to create a series of factor scores. These essentially represent a rating for each passenger on each of the different factors, based on the various attitude scores for the items that formed them. The factors scores are then used to form distinct segments of passengers using cluster analysis in order to determine "*the potential of different passenger segments to reduce their private vehicle use (research question ix).*"

Cluster analysis is an exploratory statistical technique that aims to develop meaningful subgroups (or clusters) of individuals or objects based on their similarities (or differences) on selected characteristics (Everitt et al., 2011). Herein lies a common difference between factor analysis and cluster analysis, while the former is typically used to group variables, the latter is generally applied to group objects or individuals.

There are two main forms of cluster analysis: hierarchical (agglomerative) and non-hierarchical (divisive) cluster analysis. Hierarchical cluster analysis proceeds by sequentially matching similar variables together to form clusters, which continues until one single cluster is left (Everitt et al., 2011). The clustering method is based on the (dis)similarity or distances between the variables when forming the clusters. The most common types of distance measures are Euclidean distance, Squared Euclidean distance and Manhatten distance. Euclidean distance measures the straight line distance between two points on a graph, and is commonly used in cluster analysis (Hair et al., 2005).

The researcher must then select the clustering algorithm, which describes the rules governing between which points distances are measured to determine cluster membership (Hair et al., 2005). There are five main types of clustering algorithm.

- single linkage (nearest neighbour)
- complete linkage (farthest neighbour)
- average linkage
- centroid linkage
- Ward’s method

Of these, Ward's method is distinct from the others as it adopts an analysis of variance approach to evaluate distances between clusters, rather than physical distances. Cluster membership is determined by calculating the total sum of squared deviations from the mean of a cluster. As Hair et al. (2006) state, Ward's method is generally an efficient approach and is appropriate for determining relatively equally sized clusters.

In statistical software packages, the process of hierarchical cluster analysis is generally represented as a dendrogram. The researcher chooses the point at which to 'cut' the dendrogram, and agrees on the optimum number of clusters to use in the final analysis. To some degree this decision is a subjective one on the part of the researcher, although various 'stopping rules' are discussed in the literature which each suggest different methods for identifying the optimal point at which to 'cut' the dendrogram (Hair et al., 2005; Dugard et al., 2010; Everitt et al., 2011).

Non-hierarchical (or K-Means) cluster analysis, on the other hand, is used when the researcher already has a clear idea of how many clusters exist in the data. It proceeds in the opposite fashion to hierarchical cluster analysis, starting with one single cluster and then sequentially 'splitting' it into a number of smaller clusters (Hair et al., 2005). It is common for studies to firstly employ a hierarchical clustering approach to establish some idea of the structure of the data, and then use a K-Means (non-hierarchical) cluster analysis to establish the final groupings. Anable (2005), for example adopted this approach when identifying travel behaviour segments of day trip travellers in the UK.

Cluster analysis is used in a wide variety of domains including market research. As stated by Anable et al. (2006), much of marketing theory is based on the supposition that distinct groups of people exist that possess fairly stable patterns of behaviour that lead to similar world views, systems of evaluation and consumption practices. From a travel behaviour viewpoint this form of segmentation can also be useful, as it allows decision makers to identify and evaluate opportunities for changing behaviour, such as increasing public transport use. As Elmore-Yalch (1998, Foreword) note, "*there is an increased awareness that all current and potential transit users are not the same, and that satisfying their needs, preferences and motivations requires a better understanding of who they are."* This has facilitated a move away from simple *a priori* segmentation based on socio-demographic variables, towards more advanced *post hoc* segmentation techniques that take into account a much wider range of variables (Anable, 2005).

With regard to forming policies on the back of segmentation analysis, focus is often placed on groups that inhabit the 'margins' or periphery. As stated by Anable et al. (2006), the greatest potential for behavioural change is often at the margins where attitudes tend to be more malleable and susceptible to influence. As a result it is often most effective to target policies at these groups where the chances of success are typically greatest.

5.5 Conclusions

Chapter 5 specified the research design, the data to be collected, and the research methods. Together, these are designed with a view to fulfilling the overall aim of the research.

Initially the research design was addressed in Section 5.2, which forms a framework for the research. To a significant degree this is the result of the prevailing research paradigm, or the philosophical outlook of the researcher. While it is recognised that paradigms are a complex, multi-layered mix of propositions, the philosophy and outlook underpinning the research is most closely related to the postpositivist paradigm. This viewpoint is predominantly focused on quantitative methods, yet also recognised the value of qualitative approaches, and generally takes a deductive rather than inductive approach.

In turn, the research paradigm helped to shape the six objectives and nine research questions. These represent the prevailing gaps in understanding and the ways in which the research intends to build on original knowledge.

The research design and objectives necessitated a research strategy that allowed for the collection of primary data relating to passenger surface access travel behaviour. As such, a survey was considered to be the most suitable approach. Manchester Airport was selected as the study airport for the survey because it represented an airport with existing high private vehicle use, which was highlighted in the scoping study as being especially likely to experience problems of congestion and associated negative environmental impacts (see Section 3.4). A face-to-face questionnaire survey of passengers at Manchester Airport was subsequently designed, piloted and conducted at the airport in the summer of 2011. It is from this data source that the analysis in the remaining chapters is derived.

The specific research methods employed to analyse the data was then addressed. This included descriptive statistical techniques and GIS mapping, multinomial logistics regression, structural equation modelling, and factor analysis and cluster analysis.

In the following chapter, Chapter 6, the results from the survey are reported to help assess the personal, situational and spatial characteristics of passenger mode choice. In Chapter 7 structural equation modelling is used to evaluate the underlying psychological factors impacting decisions to use alternatives to private vehicles. This is followed by Chapter 8, where distinct market segments of passengers are determined with varying potential to reduce their private vehicle use for journeys to airports.

Chapter 6

The personal, situational and spatial characteristics of passenger mode choice

6.1 Introduction

Chapter 6 seeks "to assess the personal, situational, and spatial characteristics of passenger mode choice (objective 3)". Personal characteristics relate to socio-demographic variables such as age, gender, country of residence and car access. Situational characteristics relate to factors relevant to the passenger's flight such as whether they are a business or leisure passenger, or whether they are travelling with luggage. Spatial characteristics refer to the geographic distribution of trip origins in Manchester Airport's catchment area. As the literature review explained (Section 2.3.1), these factors are thought to play an important role in passenger mode choice.

Initially, in Section 6.2 passenger mode share data from the survey is reported. This helps to provide a context for surface access at Manchester and the extent of the overall share of private vehicles journeys. Given that drop-off journeys have a disproportionate commercial and environmental impact it is especially important to consider the role of these trips in the overall mode split.

Passenger mode choice is generally acknowledged to be motivated by considerations about the relative cost, comfort and convenience of different modes (Ashford et al., 2013). However, it is not known to what degree this is common for all modes, or whether certain modes are more or less associated with different motivating factors. Therefore, in Section 6.3 the underlying factors motivating passenger mode choice are explored in order to address whether "*the factors motivating passenger mode choice vary for different modes (research question iv).*"

The chapter then addresses how personal (Section 6.4), situational (Section 6.5) and spatial characteristics (Section 6.6) are reflected in terms of passenger mode choice. This is used to create a new typology of surface access passengers (Section 6.7), and to assess which factors are significant in affecting passenger mode choice. Analysis in Section 6.4 to 6.7 seeks to address *"how the personal, situational and spatial characteristics of passenger surface access are expressed in terms of mode choice (research question v)".* Conclusions are then drawn at the end of the chapter in Section 6.8.

6.2 Passenger mode share at Manchester Airport

The overall mode share of the 860 passengers included in the survey is presented in Figure 6.1. Modes included are car (driver), car (passenger), car (rental), drop-off, taxi, bus/coach and train, and describe the main mode that each passenger used to access the airport on the day they were interviewed. Car drivers and car passengers include people parking a car at the airport. Taxi journeys include passengers travelling in traditional 'black cabs' and private hire taxis. Passengers travelling by bus/coach include those using both local service buses and long distance coaches.

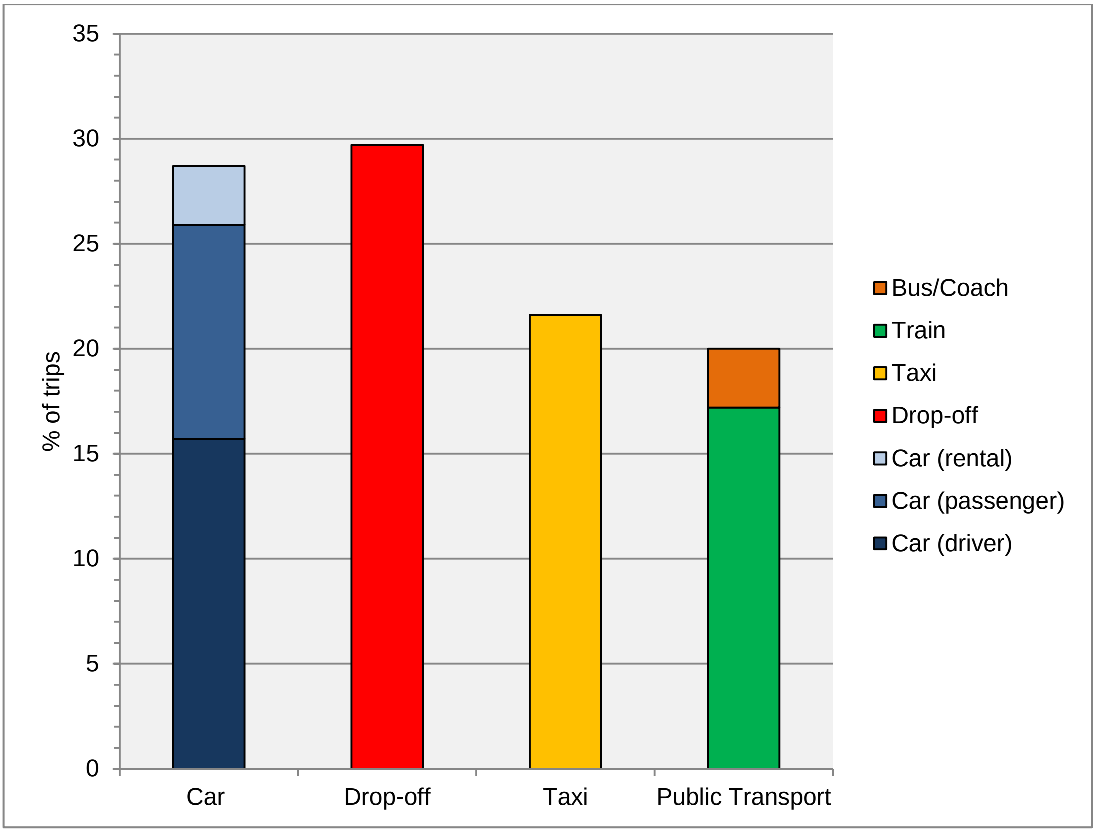


Figure 6.1 Passenger mode share in the survey

Overall, 80% of passengers in the survey travelled by private vehicles. Proportionally, this was lower than the 86.8% of private vehicle journeys reported for Manchester in the 2009 CAA Passenger Survey (CAA, 2010). Passengers who were dropped-off at the airport represent the largest share of trips (29.7%). From an airport management perspective these journeys present major challenges in terms of the additional journeys they generate, given that twice the number of journeys are made compared with driving one's own vehicle. It is therefore significant that they represent the largest share of journeys in the survey.

Car journeys collectively represent 28.7% of journeys, marginally fewer than drop-off. Car users include people driving and parking a car at the airport (15.7%), those who were passengers in a car driven by someone else who was also travelling (10.2%), and those who drove themselves in a rental car (2.8%).

Taxi journeys represent the third largest share of journeys (21.6%). Although such data could not be captured by this survey, it would be valuable in the future to try and ascertain the proportion of taxi journeys that leave the airport empty compared with those that pick-up a passenger as well as dropping one off. If the majority of taxis leave the airport empty then the environmental and congestion impact are likely to be greater than if they collect a new fare at the airport, although it is possible that licensing restrictions may exist preventing taxis originating from other areas collecting new fares at the airport.

Public transport journeys account for 20% of trips in the survey, which include train (17.2%) and bus/coach journeys (2.8%). The share of public transport journeys in the survey is slightly higher than the 15% of public transport journeys reported for Manchester Airport in the 2011 CAA Passenger Survey (2011). Here, the relatively small share of bus/coach trips was surprising given that the airport is well connected to local, regional and national bus and coach networks and has a large, modern bus and coach facility. Of the small number of passengers who did travel by bus/coach nearly half used local service buses (45.8%), followed by national or regional coach service (37.5%). The remaining 16.7% bus/coach passengers travelled on other services such as tour operator coaches.

While it was only possible to survey departing passengers during the period of data collection (i.e. the journeys to the airport), in order to include trips from the airport, passengers on the outbound leg of their trip were asked whether they intended to leave the airport by the same mode when they returned. Clearly, passengers who had parked their car at the airport intended to return by the same method, but there was some indication that a (significant) minority of passengers planned to switch modes for their journey from the airport. Overall, 11.3% of passengers signalled their intention to switch modes in this way for their return trip. Passengers who had travelled to the airport by taxi were more likely than drop-off users to switch to public transport, while the drop-off users were more likely to switch to a taxi for their return trip. It is tempting to assume that time considerations were particularly important to these passengers, who valued the perceived security of using a taxi to meet strict check-in times, but were less concerned about time pressures at the end of their trip. This provides an interesting insight for policy, namely that it might be possible to initiate mode shift for journeys from the airport even if the journey to the airport remains the same.

Analysis of the passenger mode share statistics in the survey, however, confirm that the vast majority of journeys to Manchester Airport are undertaken by private vehicles, with drop-off journeys representing the single most popular mode. Given that drop-off journeys are recognised as having the greatest impact in terms of causing congestion and atmospheric pollution, reducing the share of these trips clearly presents a major challenge for airport managers. While the share of public transport journeys was marginally higher in the survey than in the reported CAA statistics, it is noticeable that relatively few trips were made by bus/coach compared with the train.

While mode share statistics are useful for providing a ‘snapshot’ of surface access at an airport, they can tell us relatively little about the potential for mode shift or identify opportunities for reducing private vehicle journeys. To do this it is necessary to consider the underlying factors that motivate passenger behaviour, and this can provide an insight into how passenger behaviour might be changed.

6.3 Exploring passenger decisions

Analysis in this section seeks to determine whether *“the factors motivating passenger mode choice vary for different modes (research question iv).”* For the reasons described in the previous chapter (Section 5.4.1), motivational factors were determined using responses to an open ended question which asked respondents to explain the reasons why they had chosen to travel to the airport in the way that they had.

Analysis was then conducted on the pooled responses. Reasons for choosing a particular mode fell into one or more of five broad categories; cost, comfort/convenience, journey speed, time of day and mode availability. Various other reasons were also given for choosing a mode, although these were usually very specific to a particular passenger or their trip. Individual responses were allocated to one or more of the above categories and collated using a tally chart. Figure 6.2 shows the relative importance of these different factors for decisions to travel by car, drop-off, taxi and public transport.

Overall, cost and comfort/convenience were the most commonly cited reasons for choosing a mode, although there was some variation between them. Nearly half of passengers who travelled by car gave reasons relating to comfort and convenience (48.7%) as the main reason for their decision. Passengers travelling by car often cited the cost advantages compared with travelling by taxi, and the greater convenience compared with public transport. The ease of carrying luggage in a car was also commonly cited as a reason for choosing this mode.

[The car is] *"…cheaper than a taxi and we don't have to lug (sic) our bags on public transport."* - Car (driver), leisure passenger travelling from Stoke-on-Trent.

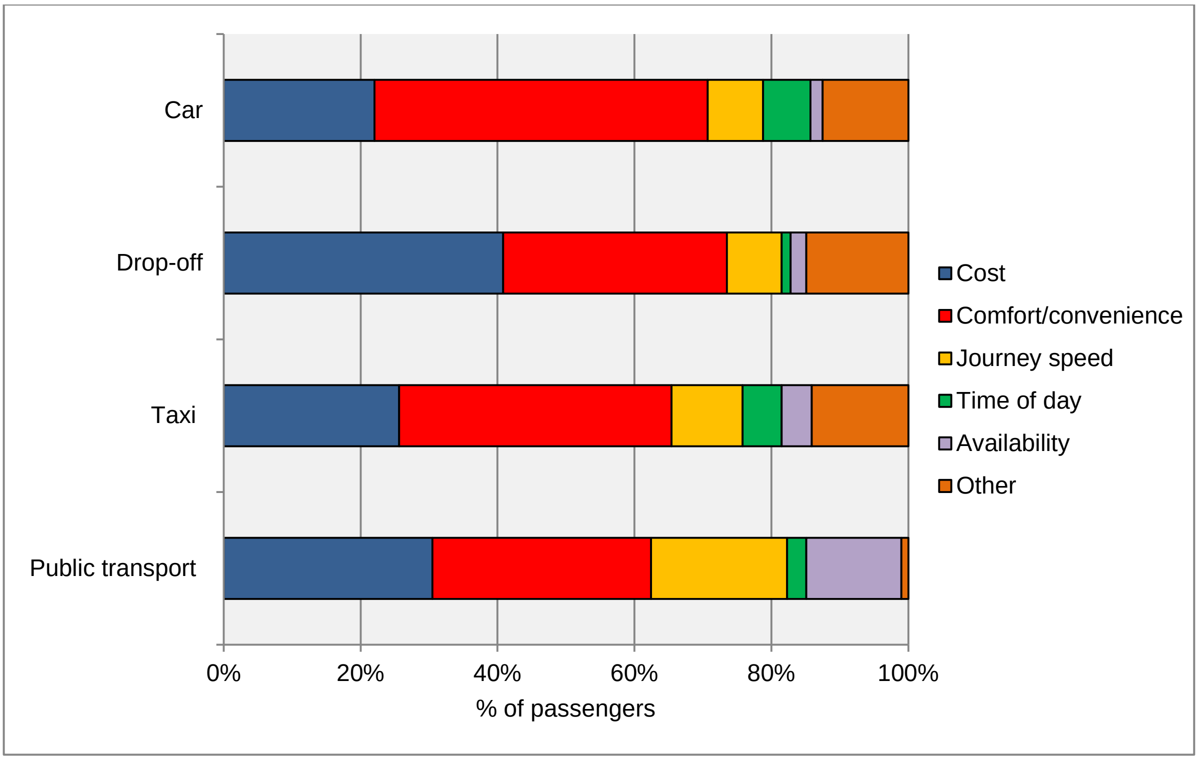


Figure 6.2 Reasons for mode choice

Cost considerations were shown to be the strongest motivator for passengers being dropped-off (40.8%). There are no immediately apparent costs associated with being dropped-off at the airport. As such, it is easy to see why it might seem an attractive option from a financial perspective. Respondents commonly referred to someone in their immediate social or family group who they relied on to drop them off. The following response was typical and illustrates this point.

"I always get dropped-off, it's free. My partner normally drives me."

- Drop-off, leisure passenger travelling from Chester.

Unlike some UK airports there is no drop-off/pick-up fee in operation at Manchester Airport, although it is quite possible that the introduction of such a fee would cause a shift in passenger perceptions about the relative cost benefits of using this mode.

Journey cost was also shown to be important for 30.5% of passengers using public transport, who generally considered buses and coaches or trains to be a less expensive option than travelling by taxi or parking at the airport. This was slightly unexpected, as it was felt that public transport journeys (especially by train) would, if anything, be perceived as being more expensive than travelling by car or taxi.

The higher relative journey speed of public transport compared with private vehicle modes was cited by 20% of public transport users as a reason for choosing these modes. In addition, the perceived ease of the connection at the airport end of the journey was also important. This reflects work by Coogan et al. (2008), who found that having an easy connection to the terminal is an important aspect of increasing public transport ridership. The following response given by a leisure passenger was typical of this viewpoint:

"*It's not too expensive and the train takes you right into the airport."*

Train, leisure passenger travelling from Merseyside.

The convenience of 'door-to-door' travel was also commonly cited as a key reason for using taxis and being dropped-off.

Although less frequently stated than other reasons, time of day played more of a role in decisions to travel by car (6.9%) and taxi (5.7%) than other modes. This exclusively concerned passengers travelling early in the morning. Various reasons were given for why and how the time of day had influenced their mode choice. Passengers who had used a car said that it was either because it had been too early for them to be dropped-off, or because public transport was not available. Several passengers also noted that trains were generally much busier and more expensive at rush hour periods, which had discouraged them from using rail travel. In comparison, passengers who had travelled by taxi generally saw it as being easier and less stressful than having to drive or find their way on public transport.

> *"It's just easier, we're tired and we know we don't have to worry about parking or anything like that."* Taxi, leisure passenger travelling from Bolton.

Mode availability was also shown to impact mode choice decisions. Overall, 13.9% of passengers travelling on public transport reported that they had used it because they did not have access to a car. Other reasons for choosing a mode were more specific to the passenger or the trip in question. For example, a small number of business passengers had travelled by taxi because it was their company's policy to do so.

In summary, cost, comfort and convenience factors were found to be the predominant motivators of mode choice. This supports the findings of Ashford et al. (2013). However, the relative importance of these factors varies between modes. While comfort and convenience appears to be the predominant factor influencing the use of car and taxis, the decision to be dropped-off is motivated primarily by cost considerations. Journey speed and mode availability are also important considerations, especially for passengers travelling by public transport. Other factors, such as the time of day, may also have a significant impact on decisions to travel by car or taxi in comparison with other modes.

This is not to say that these are the only factors that influence behaviour. As identified in the literature review (Section 2.3.1), there are a wide range of requirements and characteristics that are thought to influence surface access behaviour. The scoping study identified a need to assess how the various personal, situational and spatial characteristics of passenger surface access are expressed in terms of mode choice (Section 3.4). Consequently, the chapter now turns to addressing this issue.

6.4 Personal characteristics

Analysis in Section 6.4, 6.5, and 6.6 seeks to determine "*how the personal, situational and spatial characteristics of passenger surface access travel are expressed in terms of mode choice (research question v).*" Personal characteristics relate to socio-demographic variables such as age, gender, country of residence and car access, which are addressed below.

6.4.1 Age distribution in the survey

During their interview respondents were asked to indicate which age category they belonged to (with passengers under 18 years of age being excluded for reasons given in Section 5.3.4). Table 6.1 summarise the age distribution of passengers who responded to the questionnaire. Those aged between 45 and 54 years represented the largest age group (22.2%), followed by 18-24 and 35-44 years, who each represented 17.8% of the sample. Older people represented relatively fewer respondents in the survey. Collectively, passengers aged over 55 years represented 26.3% of the sample.

Table 6.1 Age distribution in the survey

Age group	Frequency (n)	Percentage (%) *(CAA)**
18-24 years	153	17.8 *(11.8**)*
25-34 years	135	15.7 *(15.6)*
35-44 years	153	17.8 *(19.7)*
45-54 years	191	22.2 *(22.1)*
55-59 years	80	9.3 *(9.8)*
60-64 years	81	9.4 *(8.2)*
65-74 years	58	6.8 *(8.1)*
75+ years	9	1.0 *(2.0)*
Total	860	100 *(97.3***)*

Note: * Source, CAA, 2012, ** In CAA Passenger Survey Reports the age category used is 16-24 years old, *** Passengers aged 2-16 years old are also reported by the CAA, which accounts for the remaining 2.7%.

The age distribution of passengers in the survey was then compared with passenger age data reported for Manchester Airport by the CAA (noted in brackets) (CAA, 2012). As shown, the age distribution of passengers in the survey was closely representative of the CAA data, although passengers aged 24 years and younger were slightly overrepresented in comparison with the CAA data. Figure 6.3 shows the relative mode share for different age groups in the survey. Younger passengers exhibited a relatively higher use of drop-off than other modes. Nearly half (45.1%) of passengers aged 18-24 years were dropped-off, while a third (33.3%) of passengers aged 25-34 used this mode. Slightly older passengers were also shown to be relatively high users of drop-off, 30.9% of 60-64 year olds and 37.9% of 65-74 year olds were dropped off. Drop-off use is generally lower among passengers aged between 35 and 59 years.

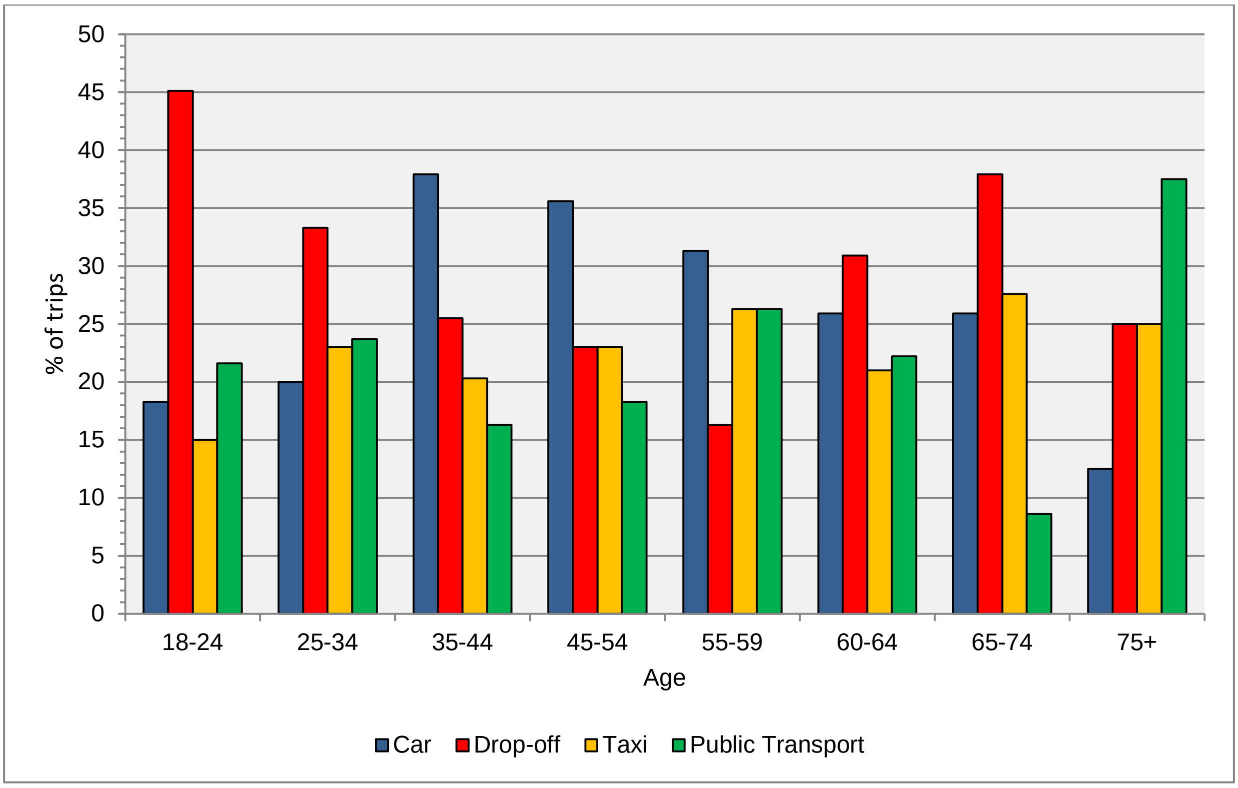


Figure 6.3 Mode share by age group

Car use is highest among passengers aged 35-44 years (37.9%), 45-54 years (35.6%), and 55-59 years (31.3%). In contrast, car use is lowest among the youngest passengers (18.3% of 18-24 year olds) and older passengers, although this should be treated with some caution given the smaller number of passengers in this age range. Taxi use does not appear to vary that much between age groups, with only a 12.6% difference between the relatively lowest users of taxis (18-24 years, 15.0%) and the highest (65-74 years, 27.6%). Similarly, public transport use does not appear to vary significantly between age groups. Passengers over 75+ years exhibit the highest relative share of public transport (37.5%), albeit with a much smaller total number of passengers. Passengers aged 55-59 years (26.3%) were also found to generally have a higher use of public transport than other age groups.

6.4.2 Gender split in the survey

Survey respondents were deliberately divided equally between males (49.7%) and females (50.3%). Figure 6.4 shows mode split by passenger gender. Relatively more passengers travelling by car (55.6%), taxi (52.7%) and public transport (51.7%) are male, whereas female passengers represent the majority of passengers who are dropped-off (57.1%).

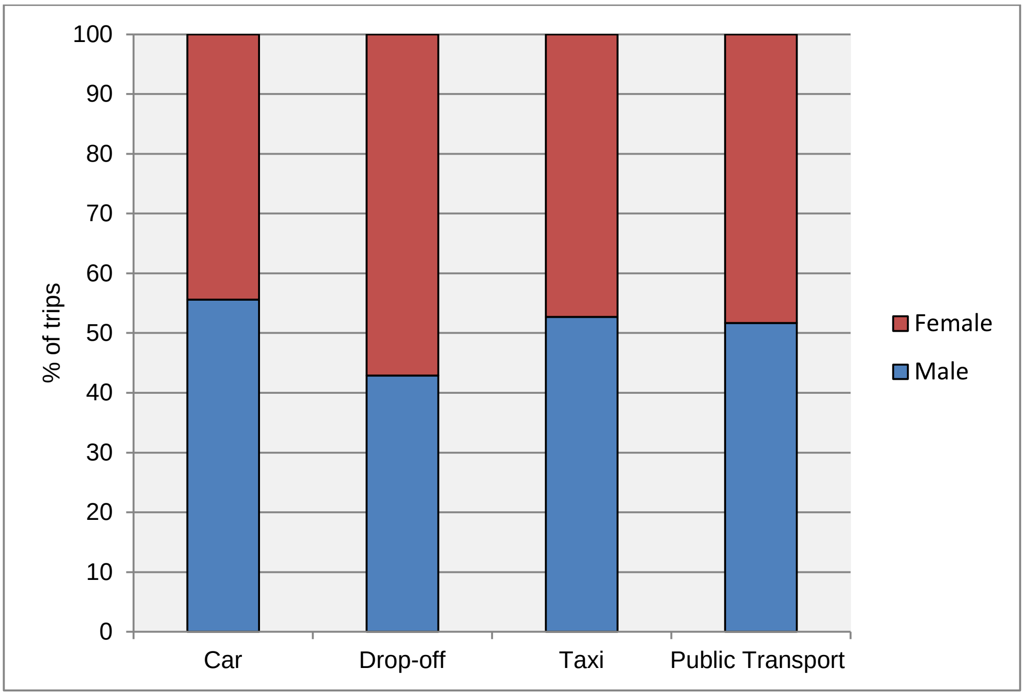


Figure 6.4 Mode share by gender

6.4.3 Country of residence and car access distribution in the survey

The ratio of resident to non-UK-resident passengers is an important consideration for airport managers as the former are far more likely to have access to a car for their journey (Coogan et al., 2008). Overall, 83.3% of passengers surveyed were UK residents. Of these passengers, 90.4% of them had regular access to a car in the UK and 96.3% were on the outbound leg of their journey. In contrast, non-resident passengers accounted for the other 18.7% of passengers in the sample, only 27.3% of whom had regular access to a car in the UK. As a result, non-resident passengers have to rely more on drop-off, taxi and public transport.

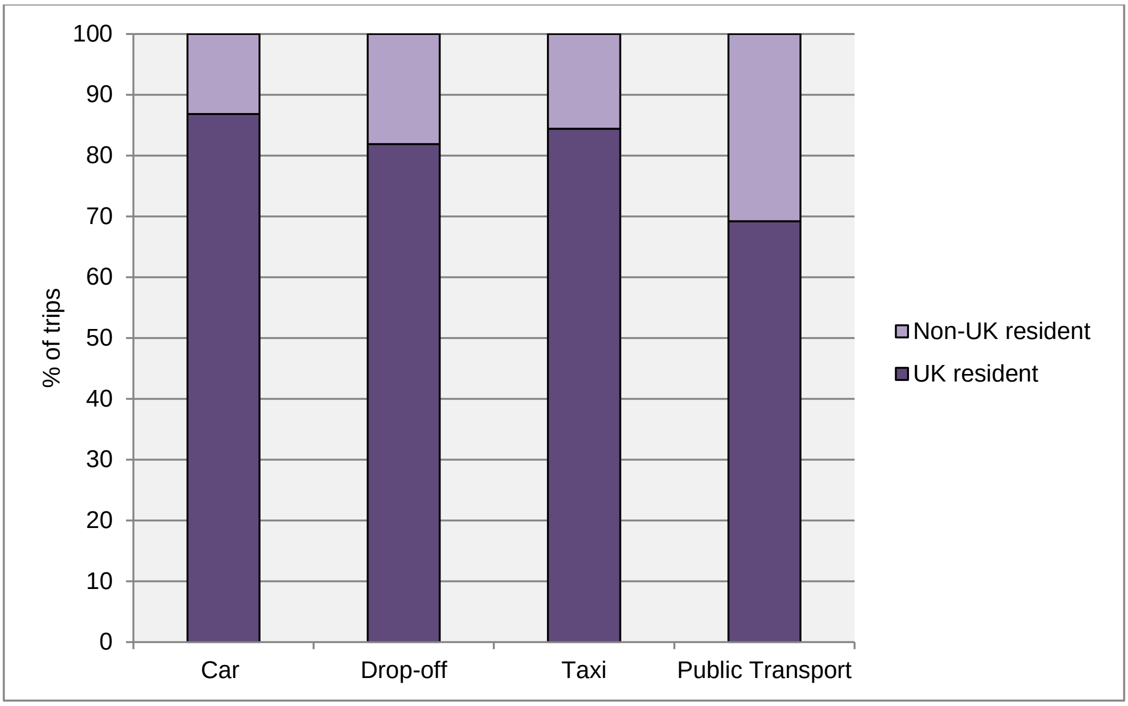


Figure 6.5 Mode share by country of residence

As Figure 6.5 shows, a relatively higher share of public transport users are non-resident passengers (30.8%) than other modes. Nearly a fifth (18.1%) of passengers dropped-off at the airport are non-resident passengers who are presumably staying with a friend or relative before departure from the UK. The 13.2% of non-resident passengers who arrived at the airport by car almost exclusively used a rented vehicle.

6.5 Situational factors

Situational factors relate to aspects specific to a passenger's trip such as trip purpose, the type of journey origin (i.e. whether they are travelling from home, their work or somewhere else), travel group size, and the time of the day they are travelling to the airport.

6.5.1 Trip purpose

Whether the passenger is travelling for leisure or business purposes is thought to play a significant role in mode choice (see Section 2.3.1). Variations in behaviour may stem from considerations about carrying luggage (Dresner, 2006), the duration of the trip (Coogan et al., 2008) or the value individual passengers place on different aspects of the trip (Pels et al., 2003; Hess and Polak, 2006).

In the present survey, three quarters of passengers (75.1%) were travelling for leisure reasons compared with 24.9% who were travelling for business reasons. Leisure passengers were more likely to be carrying luggage with them than business passengers and were planning to stay/had stayed away from home for a longer period. 89.6% of leisure passengers were travelling with checked-luggage, compared with 57.1% of business passengers. 84.0% of leisure passengers reported that their trip was lasting/had lasted for a week or more, whereas only 31.1% of business trips were of similar length.

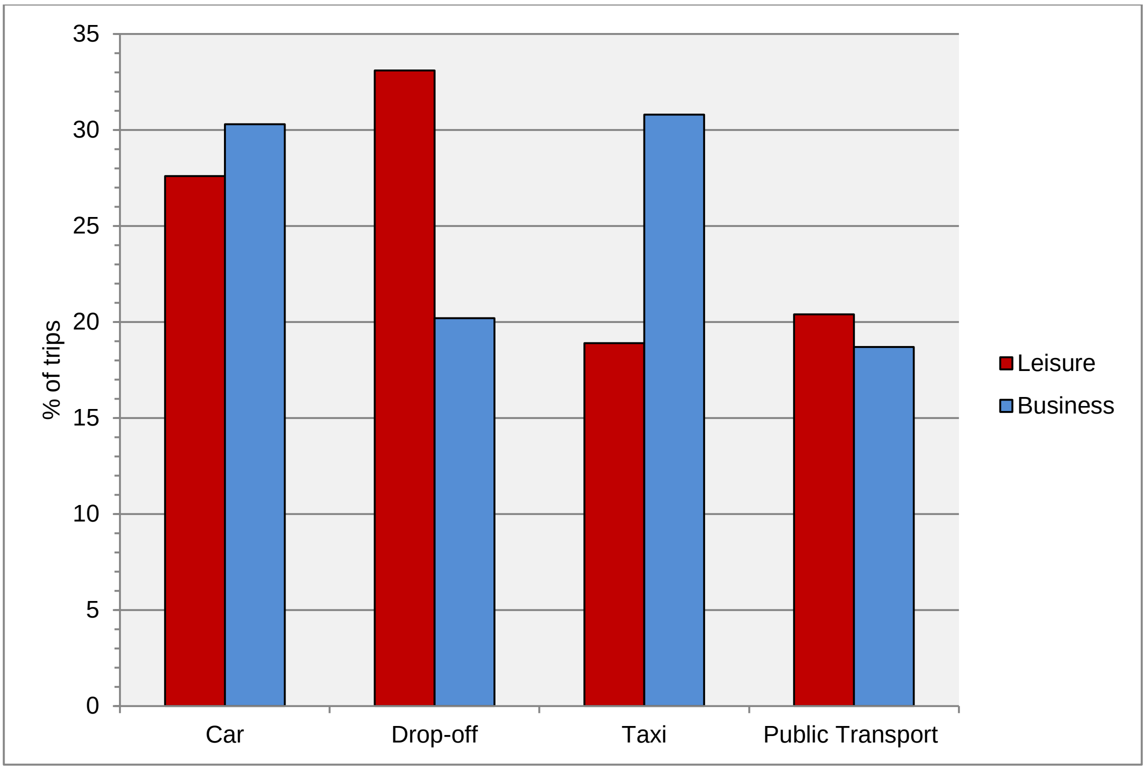


Figure 6.6 Mode share by trip purpose

Figure 6.6 compares mode choice by trip purpose. Proportionally, leisure passengers exhibit a greater use of drop-off (33.1%) than business passengers (20.2%), which supports research by Leigh Fisher Associates et al. (2000). In contrast, business passengers display a higher use of taxis (30.8%) than leisure passengers (18.9%). In essence, drop-off is associated more with leisure travel and taxis with business trips. This is perhaps because business passengers are more time sensitive, but less price sensitive than leisure passengers (see Pels et al., 2003). Typically, business passengers will have their travel costs covered by their employer, so the relative costs associated with using a taxi are likely to be less important for a passenger travelling for business rather than leisure purposes. In contrast, business and leisure passengers are shown to vary little in terms of their relative car and public transport use.

6.5.2 Type of journey origin

Table 6.2 shows the distribution of passengers in the survey according to the origins of their journey. Almost three in four passengers started their journey from home (72.7%), and such travellers are obviously more likely to have access to a car for their journey than those accessing the airport from a hotel or business address. For those people starting from home, drop-off (33.0%) and car (27.8%) were the most popular modes. Passengers travelling from a friend or relative's house represent the second largest share in the survey (10.9%), of which the majority were dropped-off (38.3%).

Table 6.2 Journey origin type

	Car (%)	Drop-off (%)	Taxi (%)	Public Transport (%)	Total (%)
Home (72.7%)	27.8	33.0	22.6	16.6	100
Friend/relative (10.9%)	21.3	38.3	11.7	28.7	100
Work (5.0%)	27.9	11.6	44.2	16.3	100
Hotel (6.4%)	32.7	16.4	21.8	29.1	100
Airport hotel (4.3%)	45.9	5.4	8.1	40.5	100
Other (0.7%)	33.3	16.7	0	50.0	100

Intuitively, passengers staying with a friend or relative are likely to be a visitor to a region (i.e. an inbound passenger). Non-resident passengers were identified during the scoping study interviews with airport managers as possible candidates for increasing public transport use (Section 3.3.2), as they are less likely to have access to a car. However, if these passengers stay with friends or relatives (who, in contrast, *are* likely to have a car) then the opportunity for effecting a behavioural change may well be reduced.

Passengers travelling to the airport from other locations include those travelling from work (5.0%), hotels (6.4%), airport hotels (4.3%), and other locations (0.7%). The relatively small number of passengers travelling from work is possibly a reflection of the low share of business passengers in the sample; it seems sensible to assume that an airport with a higher share of business passengers would show a similar increase in the share of journeys starting from a place of work. Taxi journeys account for the majority of trips from work (44.2%), which reflects high taxi use by business passengers (Figure 6.6).

Although representing only a relatively small share of journeys overall, passengers travelling from airport hotels (4.3%) were less likely to be travelling by drop-off or taxi, the most environmentally damaging modes. Instead, these passengers predominantly arrived at the airport by either car (45.9%) or public transport (40.5%). It is possible that the relatively high car use for this group is a result of airport hotels increasingly offering inclusive 'park-stay-and-fly' packages. On the other hand, because passengers staying in hotels will generally be travelling to the airport the day before they need to travel, there are unlikely to be the same time pressures associated with getting to the airport on time. If passengers are less concerned with the reliability of their journey then they may be more inclined to travel by public transport.

6.5.3 Travel group size

Figure 6.7 shows mode choice by travel group size in the survey. Nearly half of passengers in the survey were travelling on their own (47.9%). Passengers travelling in a group of two people represented the second largest share (37.4%), while those travelling in a group of three or more accounted for (14.7%) of those in the survey.

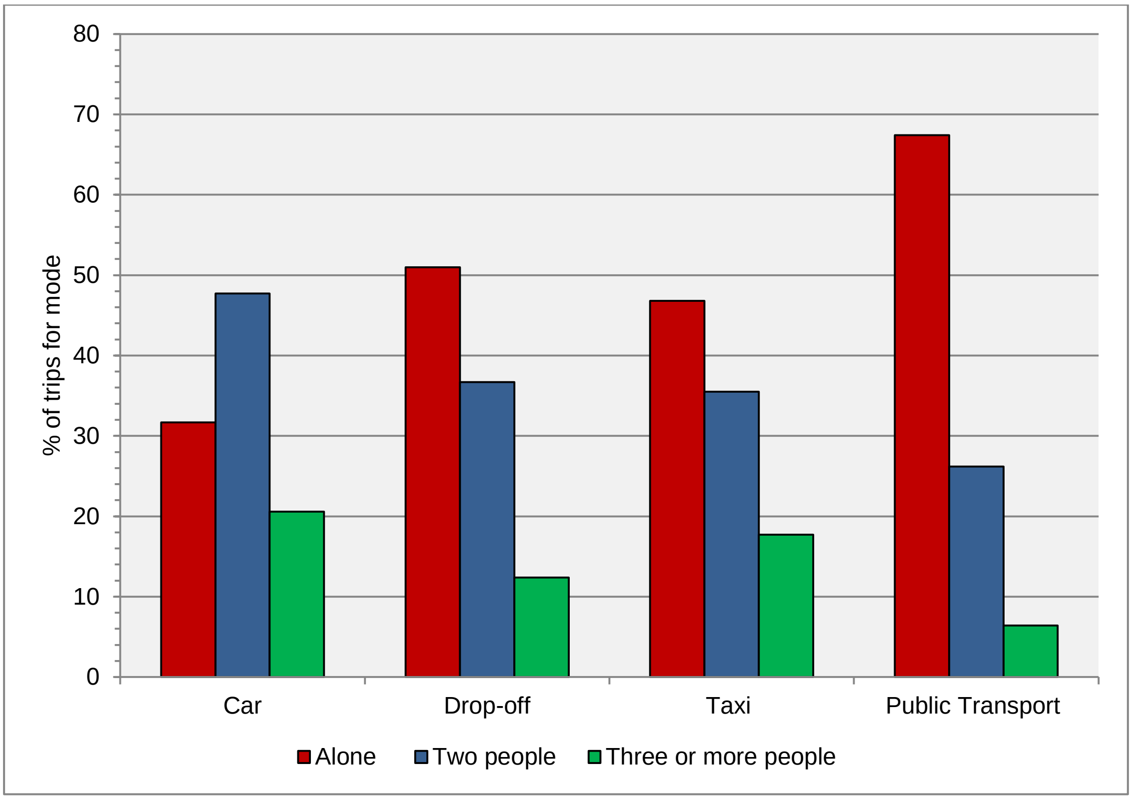


Figure 6.7 Mode share by travel group size

For passengers being dropped-off and using a taxi, the relative distribution of travel group size largely reflects the mean, with roughly half of passengers travelling alone and just over a third travelling in a group of two. In contrast, passengers travelling by car were more likely to be travelling in a pair (47.7%) than driving alone (31.7%). This is encouraging from a congestion viewpoint, as at the very least, it shows that single occupancy is not the most common form of car use. Public transport users, on the other hand, were the most likely to be travelling alone (67.4%), and far less likely to be part of a group of three of more people (only 6.4%). This is likely due to the relative cost of using public transport for a group compared with other modes. For example, the cost of three people using public transport is often likely to compare unfavourably with the shared cost of a taxi or parking at the airport.

6.5.4 Time of day

As the literature review (Section 2.3.1) identified, passenger surface access traffic is typically concentrated into several peak periods during the day (Ashford et al., 2013). Given the higher passenger volumes during peak periods the potential for congestion at these times is increased. While the specific nature of these peak periods will vary according to an airport's operational profile, typically they will occur early in the morning and towards the end of the working day. At Manchester Airport, the key peak period is between 05:00 and 07:00 local time (Manchester Airport, 2007).

Figure 6.8 shows the variation in relative mode share between 05:00 and 17:00 in the survey when passengers accessed the airport. This was calculated by subtracting two hours from the passenger's stated flight time, as this is when airlines typically advise passengers to arrive at the airport. Data is not presented for times outside of this period as too few interviews were conducted at these times for statistical validity to be assured.

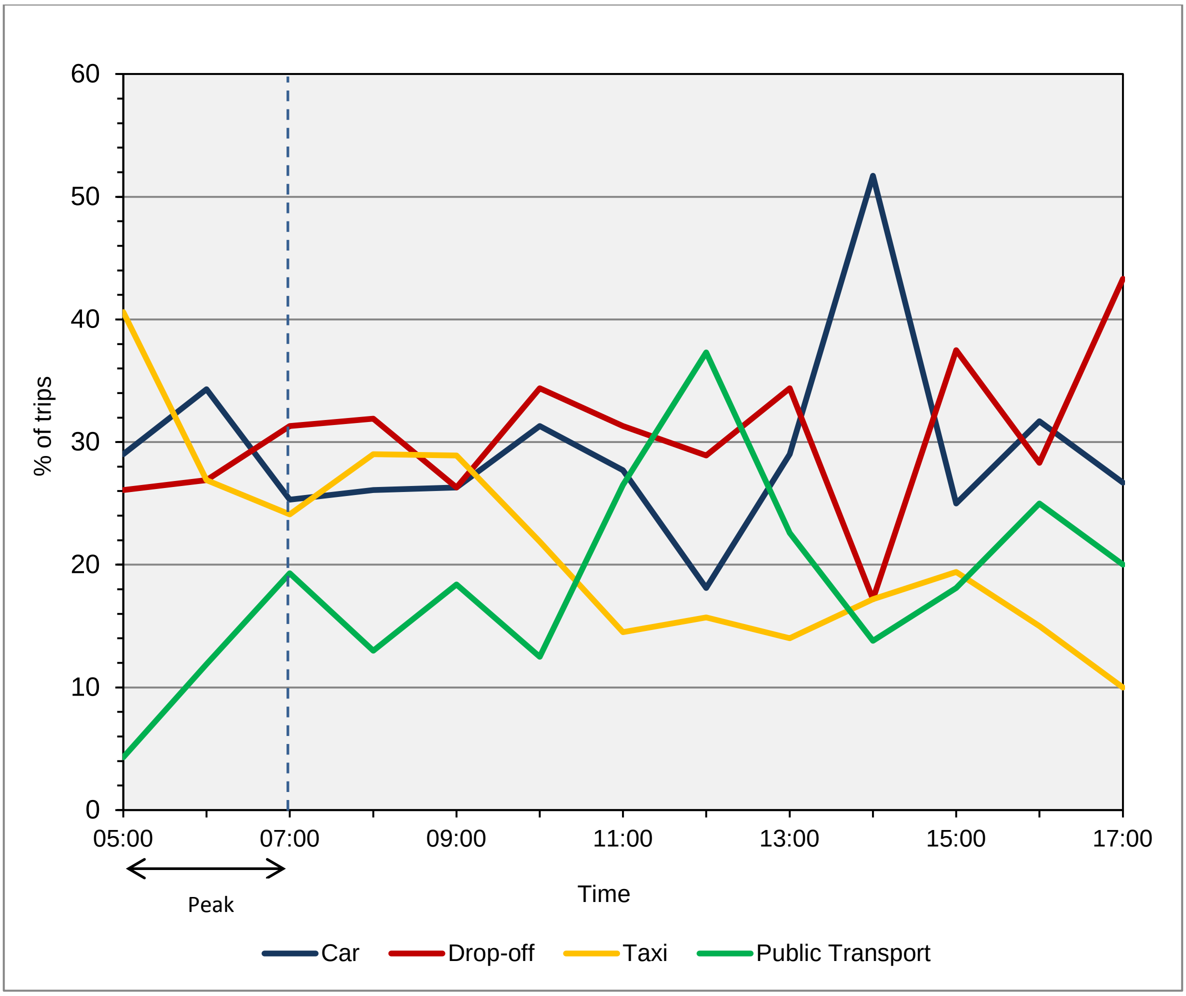


Figure 6.8 Mode share by time of day

Private vehicle trips (car, drop-off and taxi) constitute the majority of journeys in the morning peak period. Proportionally, taxis are the most commonly used mode at this time (40.5%). In contrast, public transport use is very low early in the morning, representing only 4.2% of journeys. This is presumably because public transport networks operate a limited service early in the morning. As detailed in Section 2.3.2, lack of public transport at this time also severely impacts on transport choices available to airport employees.

While the high private vehicle use during the period is unlikely to cause severe congestion on surrounding road networks given that the general ‘rush-hour’ occurs slightly later in the morning (Manchester Airport, 2007), the potential for localised congestion in and around the airport at peak times is considerably greater. Later in the morning (07:00-12:00) the share of public transport trips increases to a high of 37.3% of the total. This coincides with times when public transport services are generally more frequent. In contrast, the overall share of taxi journeys falls steadily throughout the day, and continues to decrease until 17:00 when it represents only 10.0% of trips. Generally, the share of car and drop-off trips remains fairly stable throughout the day, albeit it with a significant peak at 14:00. As such, it would appear that the early morning peak period (05:00-07:00) is when problems of congestion are at their greatest, given that taxi use is also relatively high at this time.

6.6 Spatial characteristics

Spatial aspects of surface access refer to the geographic distribution of journey origins, (see Section 2.4). Figures 6.9i-v show the geographic distribution of surface access trips by mode choice at the national level. The same data is then displayed again at the regional level in Figures 6.10i-iv. Journey origins were mapped for the 583 passengers who provided a full postcode for their journey in the survey, who represented 67.8% of the total number of passengers surveyed.

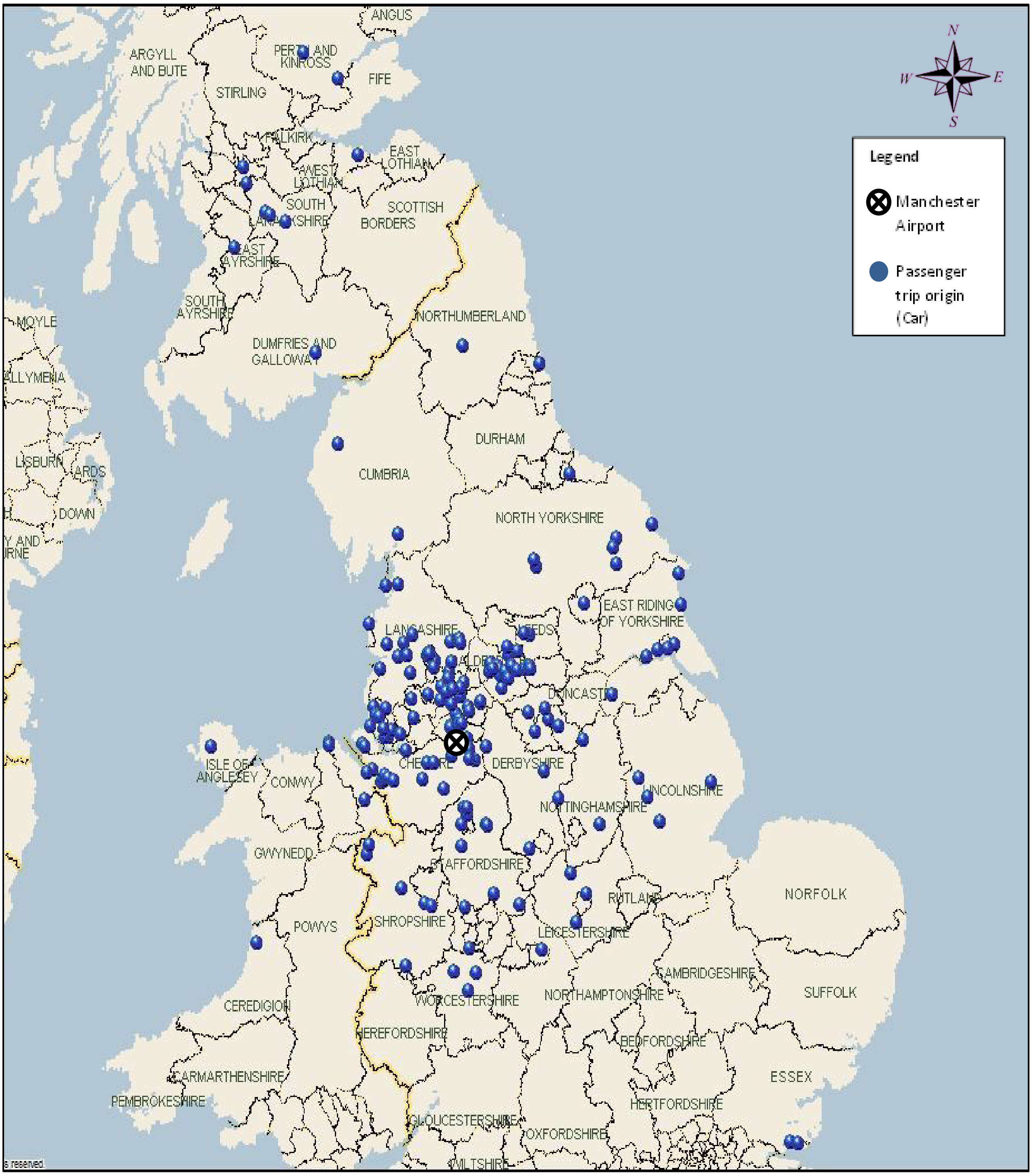


Figure 6.9i Location of trip origins by car (national view)

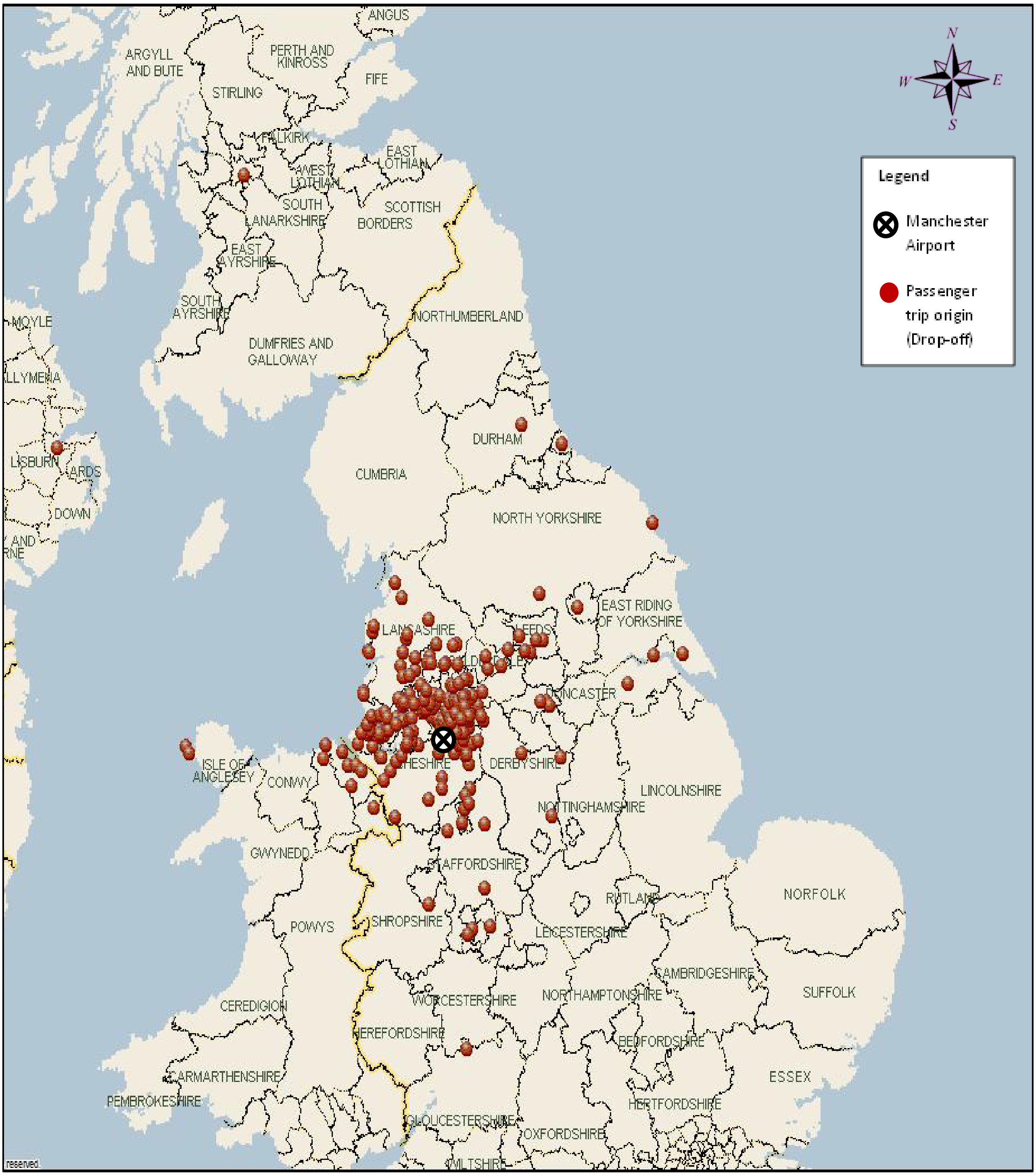


Figure 6.9ii Location of trip origins by drop-off (national view)

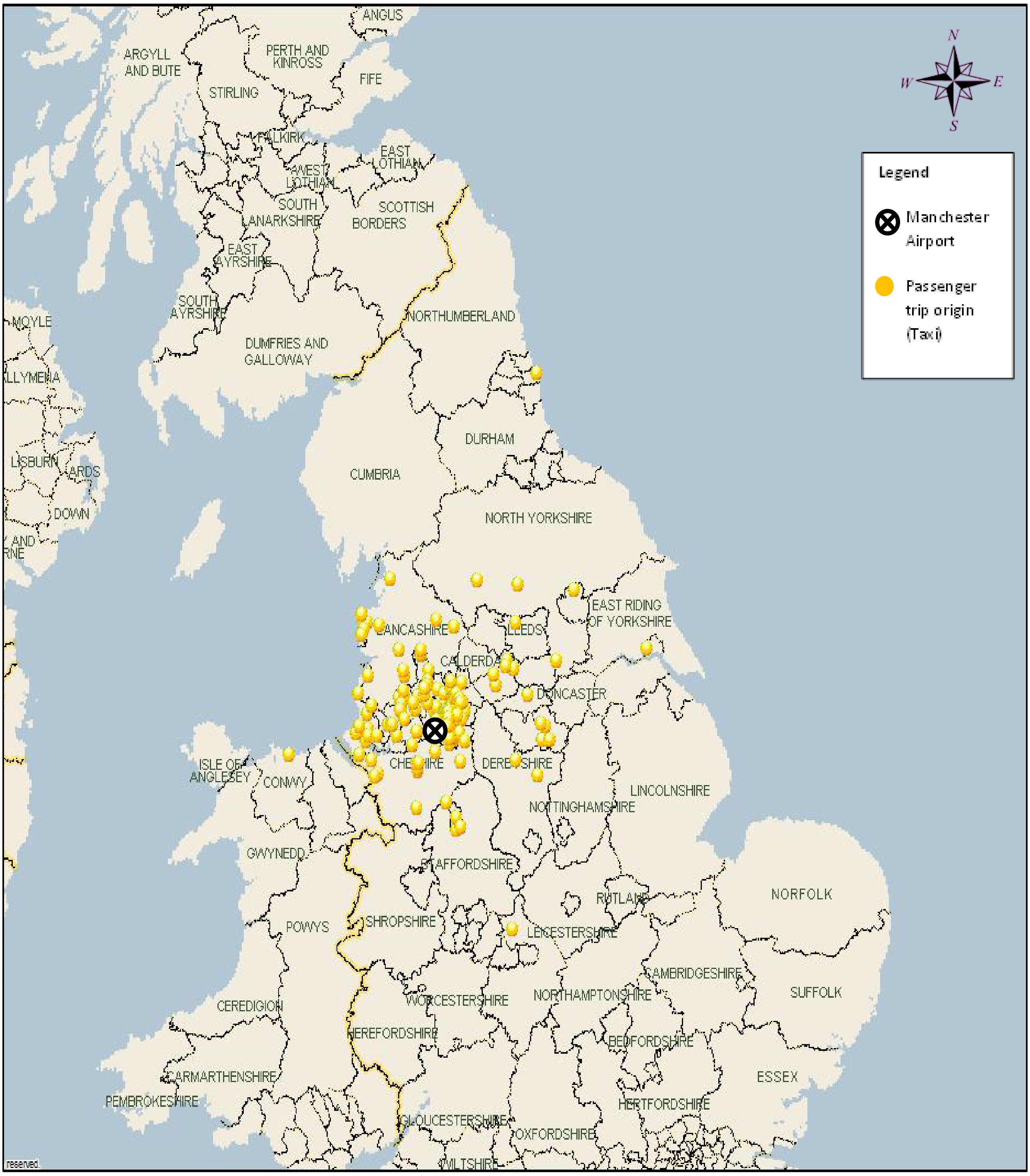


Figure 6.9iii Location of trip origins by taxi (national view)

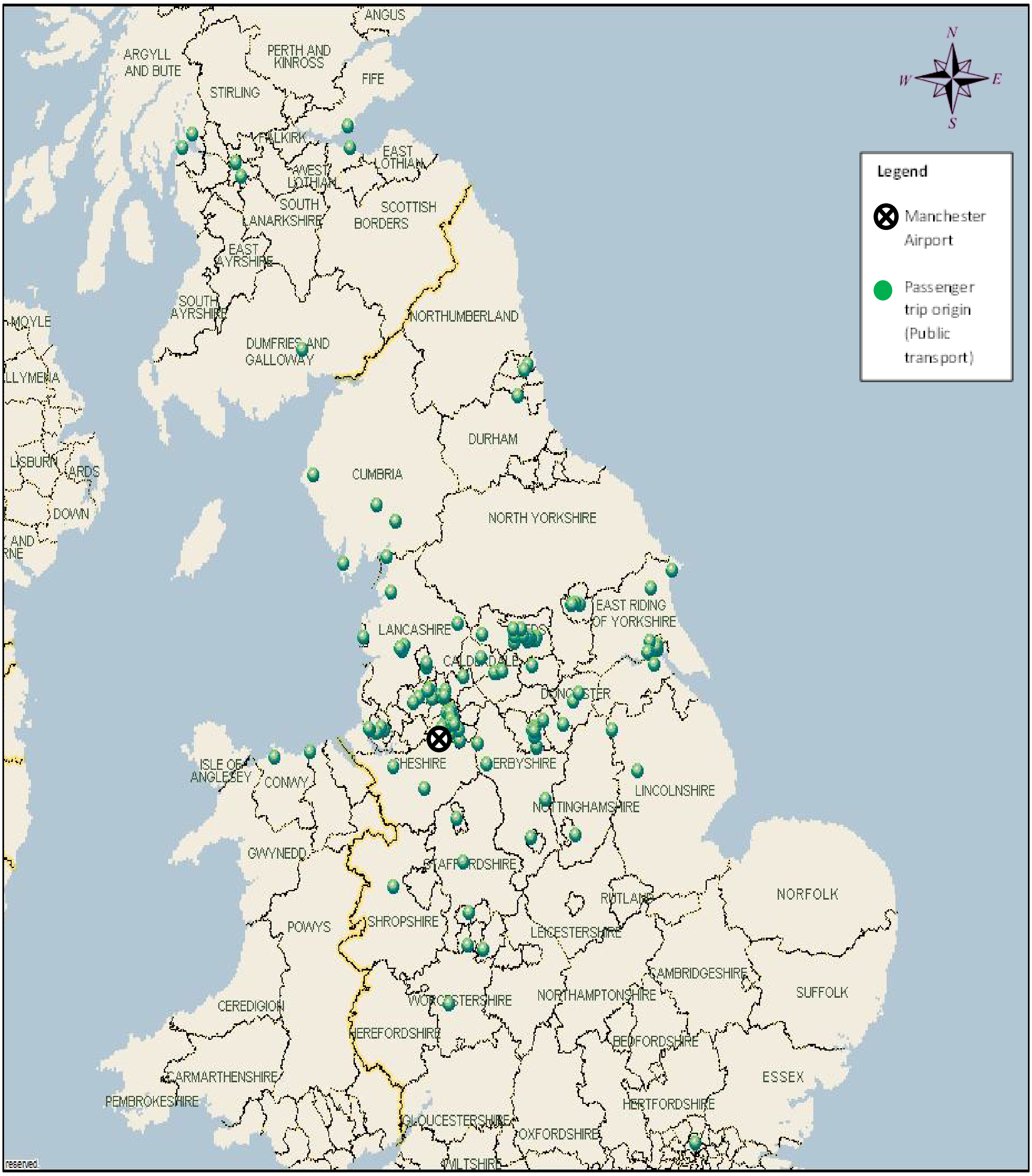


Figure 6.9iv Location of trip origins by public transport (national view)

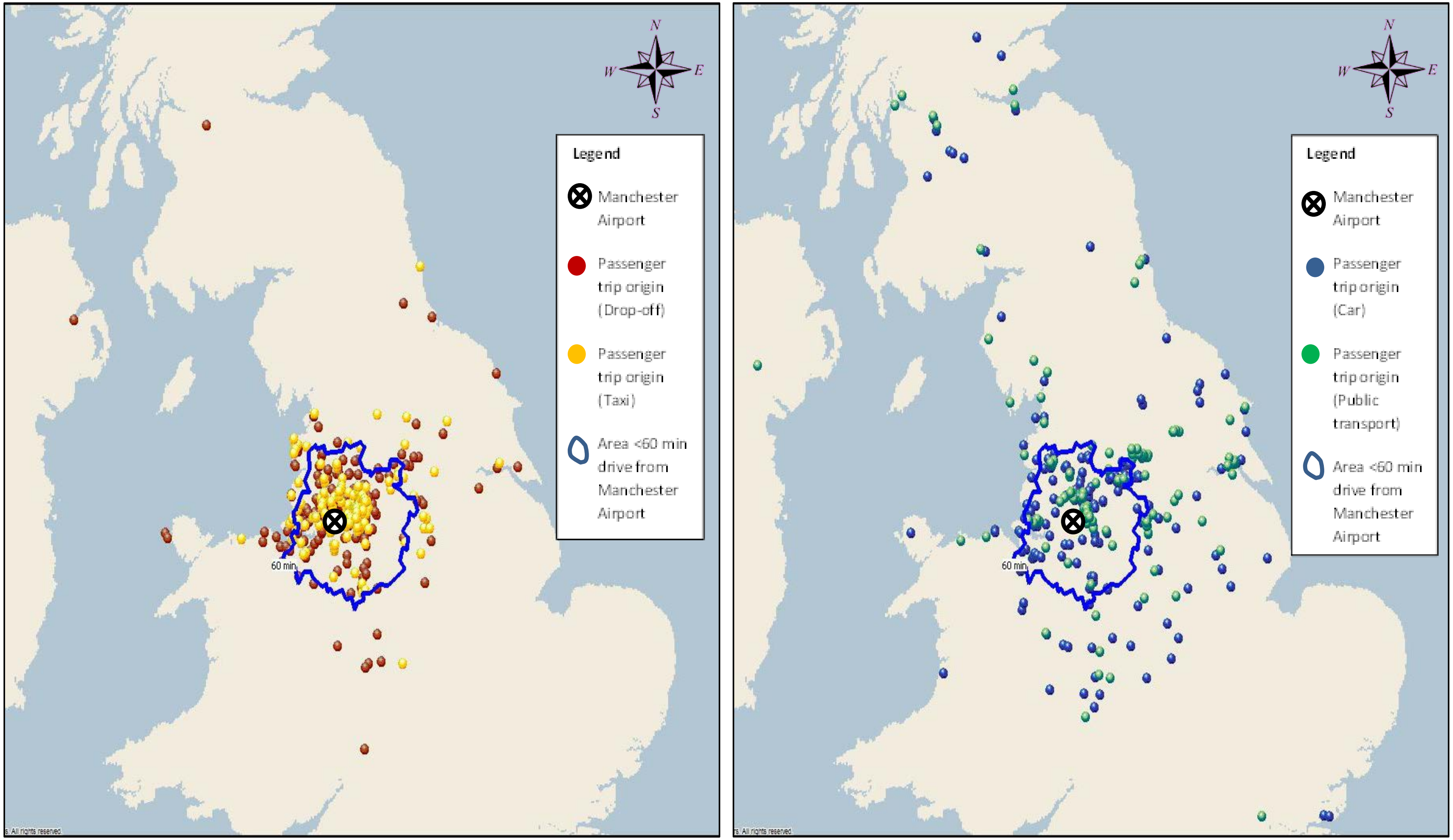


Figure 6.9v Comparison of drop-off/taxi and car/public transport journey origins relative to 1hour drive time zone from airport

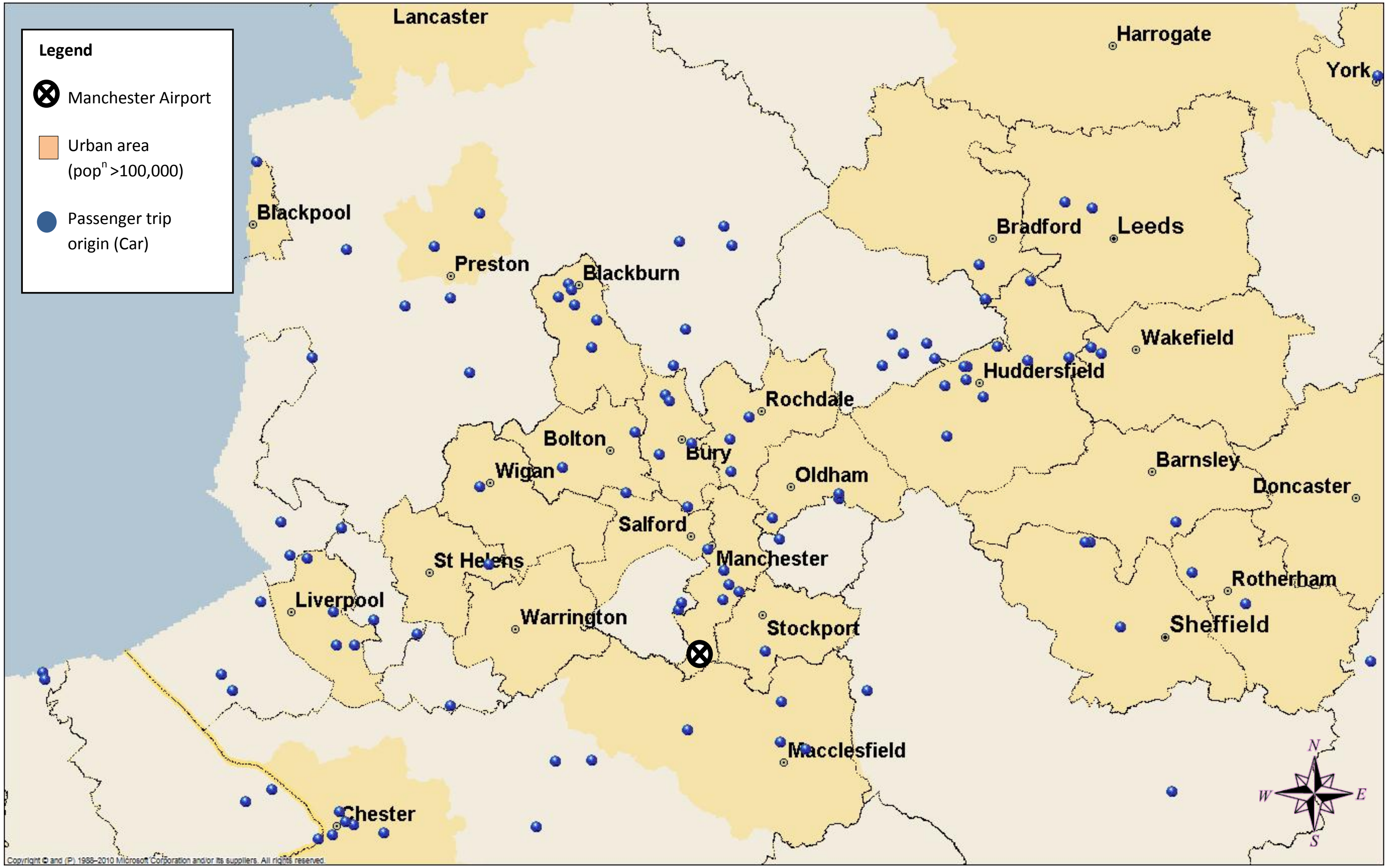


Figure 6.10i Location of trip origins by car (regional view)

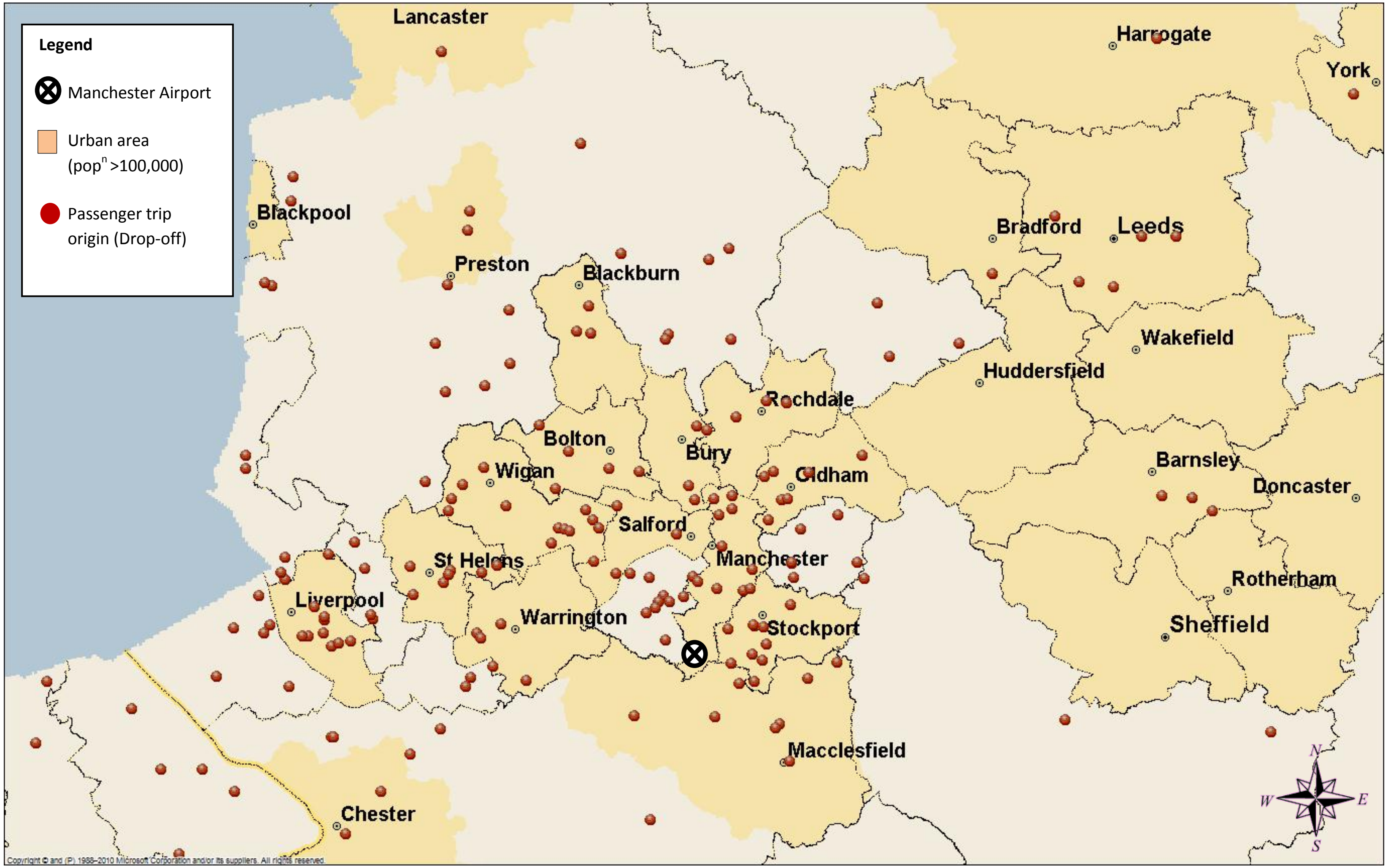


Figure 6.10ii Location of trip origins by drop-off (regional view)

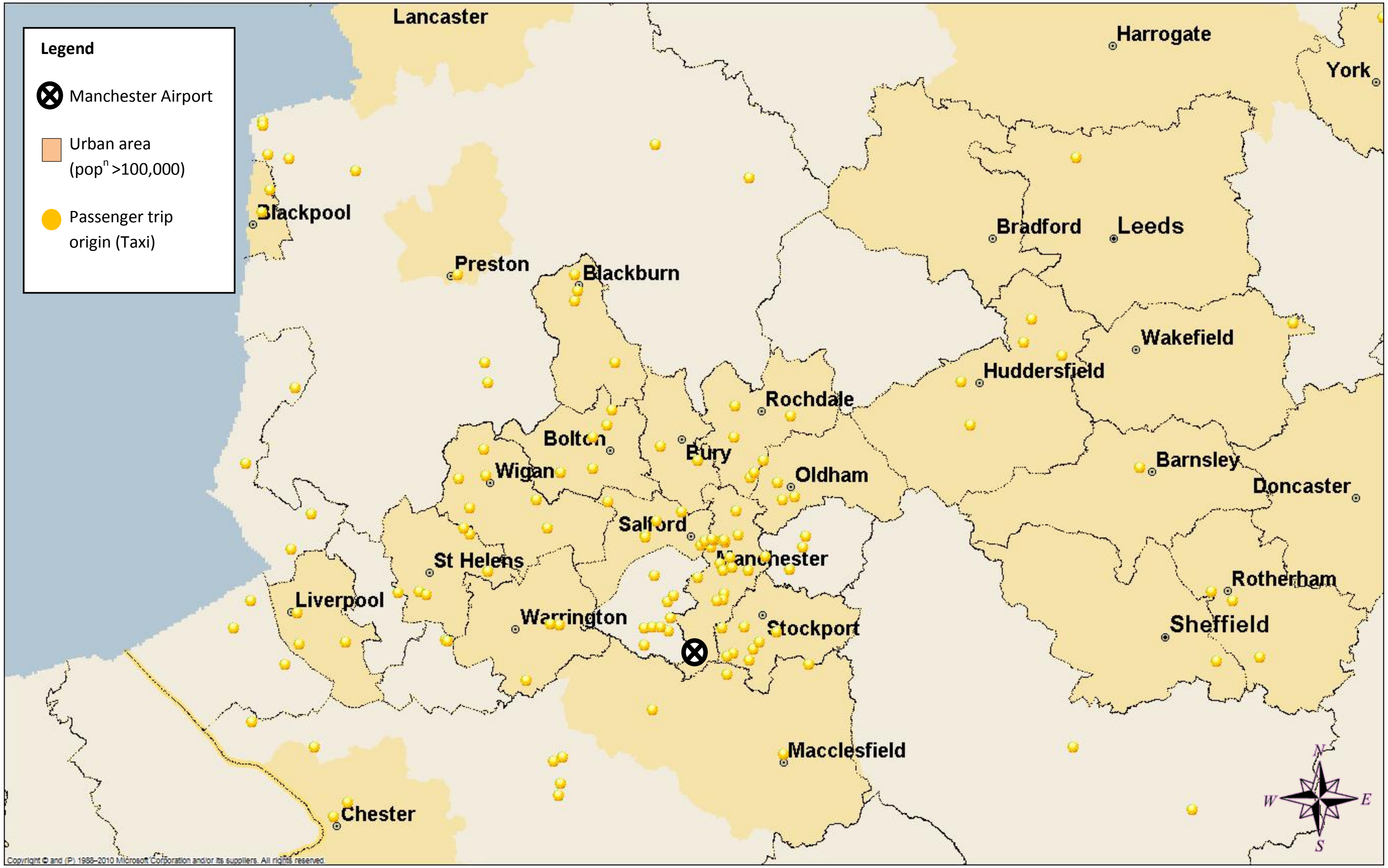


Figure 6.10iii Location of trip origins by taxi (regional view)

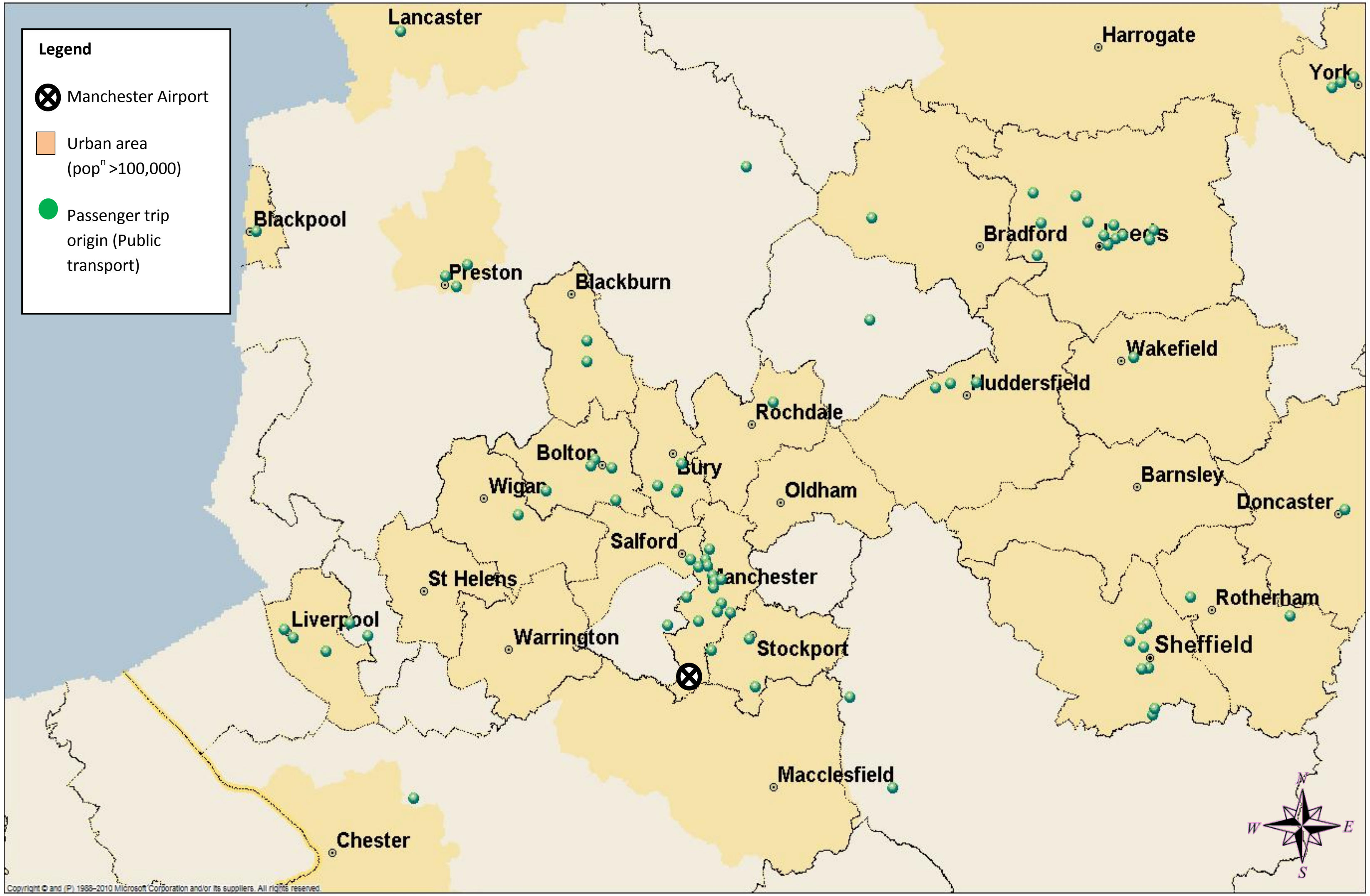


Figure 6.10iv Location of trip origins by public transport (regional view)

At the national level (Figures 6.9i-v) the spatial extent of the airport's catchment area is immediately apparent. Beyond what could be considered as the airport's primary catchment area (Greater Manchester and the surrounding counties of Cheshire, Lancashire and South Yorkshire), the airport's influence extends over much of the north, east, and north-east of England. Several passengers using private cars (Figure 6.9i) and public transport (Figure 6.9iv) travelled from as far away as Edinburgh, Glasgow and other regions in southern Scotland.

The distribution of journey trip origins to the west and to the south of the airport indicates that passengers travel from areas in north Wales and much of the East and West Midlands. Although a small number of passengers travelled from the South East of England, generally speaking the southerly extent of Manchester's influence is more limited, presumably as a result of increasing competition from Birmingham Airport and, further south, the major London airports. Overall, the mean journey distance for passengers in the survey was 48.3 miles.

There is significant variation in the distribution of trips by different modes. Trips by car (Figure 6.9i) are relatively dispersed from the airport and cover a wide area. The shortest journey by car was 5.9 miles, whereas the longest was 263.3 miles. The average car journey was 66.2 miles, which is above the mean for passengers in the survey. A significant share of car journeys originate from what Coogan et al. (2008) classify as the 'middle' and 'exurban' markets (see Section 2.4). These areas are characterised by having relatively dispersed trip origins which can make supporting fixed route public transport services challenging.

Public transport trip origins are also shown to be highly dispersed (Figure 6.9iv). The average journey distance of a passenger travelling by public transport was 65.8

miles, the shortest trip undertaken was 5.1 miles while the longest was 260.2 miles. These statistics closely match those for car journeys, so it could be assumed that public transport is used as an alternative to the car for longer-distance journeys.

In contrast, drop-off (Figure 6.9ii) and taxi trip origins (Figure 6.9iii) are far more tightly clustered around the airport, with the majority of journeys originating from Greater Manchester and the surrounding regions. The average journey distance of a passenger being dropped-off was 35.3 miles. Assuming that the driver of the vehicle returns to their point of origin once they have dropped off their passenger, this implies that the total average journey for a drop-off trip is 70.6 miles, the highest in the survey. The mean distance of taxi journeys in the survey was 30.3 miles. In this instance it is more likely that the taxi will drive elsewhere to collect another fare, rather than make the same trip in the opposite direction.

The tighter clustering of trip origins for drop-off and taxi journeys is most likely to be a function of cost relative to journey distance. For shorter journeys, drop-off and taxis provide a high level of comfort and convenience, as shown in Section 6.3. As journey distance increases, however, the comfort and convenience of using these modes is outweighed by the rising costs associated with their use.

A comparison of journey trip origins for drop-off/taxi journeys and car/public transport journeys is provided in Figure 6.9v. To help illustrate the shorter nature of drop-off/taxi journeys a 1 hour drive time zone from the airport was calculated using the GIS mapping software Mappoint and applied to the data. Drive time zones refer to expected journey times by car, and are calculated using GPS data similar to those found in satellite navigation systems. The findings demonstrate that the significant majority of drop-off and taxi journeys are from areas within an hour’s drive of the airport, whereas car and public transport journeys are both longer and more dispersed.

Analysing the same data at the regional level (Figure 6.10i-iv) it is possible to ascertain the relative share of journeys that originate from urban areas (defined here as towns or cities with a population of over 100,000 people). As discussed in Section 2.4, typically fewer than 30% of trips begin or end in downtown or highly populated areas (LeighFisher et al., 2010), although some estimates suggest that for certain airports it is closer to 10-15% of trips (Mandle et al, 2002). Car journeys (Figure 6.10i) are relatively dispersed across the region. Intuitively this makes sense, as passengers travelling in their car are likely to be travelling from home in predominantly residential areas. The same is also true for drop-off journeys (Figure 6.9ii), which are more concentrated than car journeys but still relatively sparsely distributed across the region.

In contrast, for taxi (Figure 6.10iii) and public transport trip origins (Figure 6.10iv) the share of journeys starting in city centres and urban areas is considerably higher. The tight clustering of taxi trip origins in the centre of Manchester is especially apparent. Again this makes sense, given that taxi firms will tend to be based in urban areas, and taxi ranks are generally situated in key locations in a city. Given that public transport links are also better in city centre locations, it is notable that a significant share of passengers travelling from these areas chose to use a taxi to travel to the airport rather than use public transport. For these passengers it would appear that there are other factors governing their choice of mode other than ease of access alone.

Having said that, the majority of public transport trips do predominantly originate in urban areas, with passengers travelling from cities such as Liverpool, Preston, York, Leeds and Sheffield. However, not all urban areas close to the airport have passengers travelling by public transport (Figure 6.10iv). For example, no passengers travelled to the airport from Macclesfield (12 miles away) despite its relative proximity to the airport.

6.7 Developing a passenger typology based on combined personal, situational and spatial characteristics

In this section multinomial logistic regression is used to develop a typology of surface access passengers using the personal, situational and spatial characteristics discussed in Section 6.4, 6.5 and 6.6. As discussed in Chapter 5 (Section 5.4.2), multinomial logistic regression identifies the variables that collectively distinguish cases belonging to different categories of an unordered nominal (or categorical) dependent variable (Howitt and Cramer, 2011). In this case the dependent variable refers to mode choice (car, drop-off, taxi or public transport), while the explanatory variables relate to the different personal, situational and spatial characteristics analysed in Section 6.4, 6.5 and 6.6. The procedure will thus show the relative influence of these factors in passenger mode choice decisions, and develop a typology of surface access passengers based on key personal, situational and spatial characteristics.

6.7.1 Defining the survey sub-sample

As stated in Section 6.6, accurate spatial information regarding passenger journeys could only be obtained for respondents who provided a full postcode for the origin of their surface access trip in the survey. As this information was needed for inclusion in the multinomial logistic regression procedure, the analysis is based on a sub-sample of 583 respondents who provided a full postcode for the origin of their trip.

This sub-sample was compared with the full sample in terms of relative mode share, trip purpose, origin type, age and gender, to ascertain the extent to which it was representative of the data as a whole. The comparison of the sub-sample (*n=583*) with the full sample (*n*=860) is shown in Table 6.3.

Table 6.3 Characteristics of the sub-sample and comparison with the full sample

		Sub-sample *(n=583)*		Full sample *(n=860)*	
		n	*%*	*n*	*%*
Mode	Car	155	26.6	243	28.7
	Drop-Off	182	31.2	259	29.7
	Public transport	114	19.6	172	20.0
	Taxi	132	22.6	186	21.6
Trip purpose	Leisure	460	78.9	662	77.0
	Business	123	21.1	198	23.0
Origin type	Home	489	83.9	625	72.7
	Other	94	16.1	235	27.3
Leg of trip	Outbound	528	90.6	694	80.7
	Return	55	9.4	166	19.3
Age	18-34	199	34.1	288	33.5
	≥35	384	65.9	572	66.5
Gender	Male	287	49.2	433	50.3
	Female	296	50.8	427	49.7

The key differences between the sub-sample and the full sample relate to origin type and the proportion of passengers on the outbound leg of their trip. A larger proportion of passengers in the sub-sample had started their journey from home. Such passengers are more likely to know the full postcode for the origin of their trip (and thus be included in the sub-sample) than passengers travelling from elsewhere.

For example, it is unlikely that someone would be able to recall the postcode of a hotel they were staying in, whereas they would be more likely to recall their home postcode. Proportionally more passengers in the sub-sample were travelling on the outbound leg of their trip than in the full sample. Again, this is likely to be because a larger share of passengers in the sub-sample were travelling from home, who, by definition, are embarking upon the outbound leg of their trip.

6.7.2 Variables included in the modelling procedure

The dependent variable in the procedure was defined as passenger mode choice; car, drop-off, taxi or public transport. The decision to use four variables for mode choice was motivated by the need to strike a balance between incorporating as broad a range of mode choices on the one hand, and having sufficient cases in each variable to support statistically valid conclusions on the other.

In multinomial logistic regression one category of the dependent variable is arbitrarily defined by the researcher as the reference category. This creates a number of logistic regression models where the probability of a case belonging to the reference category is compared with the probability of belonging to each of the other categories of the dependent variable. The choice of the reference category does not affect the model outputs, merely the way they are presented (Howitt and Cramer, 2011). Here, the reference category was defined as passengers who travelled by public transport as this is a crucial consideration in effecting a modal shift.

The independent (or explanatory) variables in the procedure were designed to reflect the various personal, situational and spatial characteristics addressed in Section 6.4, 6.5 and 6.6, respectively. Ten independent variables were included in the procedure;

age (AGE), gender (GENDER), car access (CAR), trip purpose (TRIP), leg of trip (LEG) checked luggage (BAG), trip origin (ORIGIN), travel group size (GROUP), time of flight (TIME), and journey distance (DISTANCE). A utility function for surface access mode choice can therefore be expressed as:

$$\begin{aligned} U(MODE) = \alpha + \beta_1(AGE) + \ & \beta_2(GENDER) + \beta_3(CAR) + \beta_4(TRIP) \\ & + \beta_5(LEG) + \beta_6(BAG) + \beta_7(ORIGIN) + \beta_8(GROUP) \\ & + \beta_9(TIME) \ + \beta_{10}(DISTANCE) + \varepsilon \end{aligned}$$

Where:

$U(MODE)$	is the utility of a mode
α	is the constant term
β	is the coefficient of the independent variables
$\boldsymbol{\varepsilon}$	is the error term

Source: Adapted from Gosling, 2008

To ensure easier interpretation of the model outputs, each of the independent variables were defined as dichotomous variables, as shown in Table 6.4.

Table 6.4 Summary of independent variables

Variable		Categories
Personal	AGE	*(≥60years/18-59 years)*
	GENDER	*(Male/Female)*
	CAR	*(Yes/No)*
Situational	TRIP	*(Business/Leisure)*
	LEG	*(Outbound/Return)*
	BAG	*(No/Yes)*
	ORIGIN	*(Home/Not home)*
	GROUP	*(Alone/Two or more people*
	TIME	*(Early morning/Not early morning)*
Spatial	DISTANCE	*(≥1 hour drive/<1 hour drive)*

Personal factors included in the model relate to the analysis in Section 6.4. Passenger age (AGE) was defined as passenger aged 60 years and older, and those aged 18-59 years, which reflected the different mode share of the former (see Figure 6.3). Passenger gender (GENDER) was included as an independent variable in the model given that analysis in Section 6.5 showed that relatively more passengers travelling by car taxi and public transport were male, whereas female passengers represented the majority of passengers who are dropped-off. Car access (CAR) was also included in the model.

Considering situational factors, whether the passenger was travelling for leisure of business purposes (TRIP) was included. This reflected both existing research (for example, Dresner, 2006; Coogan et al., 2008; Pels et al., 2003) and the interviews conducted with airport managers as part of the present research (see Section 3.3.2), who reported that trip purpose was a key factor in mode choice.

The leg of the passenger's journey (LEG) was included rather than their country of residence (see Section 6.4.3). This avoided incurring potential errors occurring from passengers who were UK residents returning home on a domestic flight. A separate measure of whether the passenger was travelling with checked-in luggage (BAG) was also included in the procedure, although as shown in Section 6.5.1, this may be a function of trip purpose. This decision was informed by the work of Kazda and Caves (2008), and Coogan et al., (2008), and the interviews with airport managers (see Section 3.3.2) who reported that accommodating passengers with luggage was an important part of encouraging public transport use. Measures of whether the passenger was travelling from home or not (ORIGIN) and travel group size (GROUP) were also included, reflecting analysis in Section 6.5.2 and 6.5.3 respectively, showing that passengers who had travelled from home had a higher use of car and drop-off, whereas passengers who used public transport were proportionally more likely to be have travelled alone. For the factor relating to flight time (TIME), passengers travelling early in the morning were defined as those accessing the airport in the peak period between 05:00 and 07:00, reflecting analysis in Section 6.5.4.

One independent variable relating to spatial factors (DISTANCE) was also included in the procedure. As analysis in Section 6.6 shows, drop-off and taxi journeys originated from closer to the airport than car and public transport trips. For the purpose of the multinomial logistic regression procedure, passengers were categorised as being either 1 hour drive away or further from the airport, or less than 1 hour drive away from the airport. This was undertaken using the estimated drive time data obtained in Section 6.6. Estimated drive time is thus employed in the modelling process as a proxy for journey distance.

6.7.3 Model results and interpretation

The regression parameters from the model are shown in Table 6.5. As noted in Section 6.7.2, public transport use was defined as the reference category for the procedure, meaning that all standardised regression coefficients (β) are interpreted in relation to this category. Coefficients indicate how many standard deviation units the dependent variable will change for one standard deviation unit change in the independent variable (Bryman and Cramer, 1997). In other words, it shows to what extent changes in the independent variables affect the dependent variable. A positive coefficient (which is significant at either the 1% or 5% level) means that the particular variable has a positive impact on utility and so reflects a higher probability of choosing the alternative to which it is applied. Generally speaking, coefficients ≥1.0 are considered to represent a large effect (Moutinho and Hutcheson, 2011). For example, in Table 6.5 the independent variable relating to travelling on the outbound leg of a journey (LEG) for car users has a strong positive coefficient (β= 1.278) and is significant at the 1% level. This indicates that passengers on the outbound leg of their journey are more likely to choose to travel by car than they are to travel by public transport.

Where there is a negative coefficient the opposite is true. This indicates that the variable has a negative impact on utility and so reflects a lower probability of choosing the alternative to which it is applied, and, in turn, a greater probability of choosing the designated reference category, which in this case represents choosing public transport.

As discussed in Section 5.4.2, in multinomial logistic regression Pseudo R-Square statistics are calculated as part of the modelling output. These are analogous to R-Squared statistics in multiple regression, and show the combined relationship of the independent variables with the dependent variable (Howitt and Cramer, 2011). In other words they provide an indication of how well the model 'fits' the data. Three pseudo R-Square statistics are reported in SPSS and are shown in Table 6.5: Cox and Snell (0.355), Nagelkerke (0.380), and McFadden (0.160), which are shown in Table 6.5. Using the rule of thumb provided by Howitt and Cramer (2011) and McFadden (1973) (see Section 5.4.1), there is a reasonable fit with the data overall.

Table 6.5 Regression Parameters

Variable	Model results		
	β	*Std. error*	*Sig.*
Car			
AGE	0.105	0.383	0.785
GENDER	0.178	0.286	0.533
CAR	3.777	1.047	0.000**
TRIP	1.930	0.447	0.000**
LEG	1.278	0.777	0.009**
BAG	-0.390	0.406	0.337
ORIGIN	0.179	0.416	0.667
GROUP	-1.877	0.353	0.000**
TIME	0.793	0.396	0.045*
DISTANCE	-0.239	0.291	0.411
Dropped-Off			
AGE	0.244	0.360	0.499
GENDER	-0.280	0.269	0.299
CAR	0.851	0.351	0.015*
TRIP	0.302	0.413	0.465
LEG	-0.589	0.585	0.314
BAG	-0.595	0.371	0.109
ORIGIN	1.594	0.510	0.002**
GROUP	-0.613	0.294	0.037*
TIME	0.170	0.393	0.665
DISTANCE	-1.752	0.282	0.000**
Taxi			
AGE	0.649	0.376	0.185
GENDER	-0.064	0.291	0.826
CAR	0.713	0.391	0.068
TRIP	1.724	0.426	0.000**
LEG	-0.128	0.602	0.831
BAG	-1.489	0.439	0.001**
ORIGIN	0.197	0.469	0.674
GROUP	-1.160	0.329	0.000**
TIME	1.043	0.397	0.009**
DISTANCE	-1.759	0.311	0.000**
Public Transport is the reference category			*Model Fit Indices: Cox and Snell=0.355 Nagelkerke=0.380 McFadden=0.160*

Note: Reference category is Public Transport, all other regression coefficients are interpreted in relation to this category, * Significant at 5% level(<0.05), ** Significant at 1% level (<0.01)

From the regression parameters in Table 6.5 it is apparent that different variables are associated with different modes. Perhaps predictably, car users were defined primarily by having access to a car in the UK (β= 3.777). This is to say that car users are more likely to have access to a car than public transport users. However, the role of trip purpose in determining car use is of greater insight, as the results demonstrate that car users were more likely than public transport users to be business passengers (β= 1.930). This was unexpected, as analysis in Section 6.5.1 had suggested that trip purpose was more of an important factor in drop-off and taxi use (see Figure 6.6).

A passenger's age or gender was not shown to be significantly associated with car use, or indeed any of the other modes in the model. This was unexpected, as analysis in Section 6.4.1 and 6.4.2 suggested that mode choice varied, at least to some extent, according to age and gender. In particular it was thought that a passenger's age may have been significant in car use, given that people aged over 60 years old exhibited a relatively low use of this mode (see Section 6.4.1). Aside from car access, results from the modelling procedure indicate that personal factors do not play a significant role in mode choice decisions.

Passengers travelling to the airport in the early morning peak period (05:00-07:00) were more likely to be travelling by car than public transport (β= *0*.793). Although flight time was less important for car users than having access to a car and trip purpose, the finding is consistent with the analysis in Section 6.5.4.

Passengers who were dropped-off at the airport vary from car users in terms of their situational and spatial characteristics. While passengers who were dropped-off were also likely to have access to a car (β= 0.851), trip purpose was not shown to be a significant variable determining the use of this mode. This was also unexpected given that leisure passengers were shown to represent a much larger share of drop-off users than business passengers in the survey (see Section 6.5.1 and Figure 6.6). Drop-off users were further differentiated from car users by the varying role of journey origin type. While origin type was not a significant variable for car users, it played a much larger role for drop-off. Passengers who started their journey from home were considerably more likely to choose to be dropped-off than use public transport (β= 1.594). Unlike car users, the leg of a passenger's journey was not found to be a significant factor in determining passengers who were dropped-off.

As already noted, a passenger's journey distance was accounted for in the model by using a measure of their estimated drive time (≥1 hour drive/ <1 hour drive). Findings from the model show that distance was a key factor differentiating drop-off and taxi users from those travelling by car or public transport, which supports similar findings in Section 6.6. Passengers who started their journey from more than 1 hours drive away from the airport were less likely to be dropped-off (β= -1.752) or use a taxi (β= -1.759) than use public transport. This is to say that passengers travelling further to the airport were more likely to use public transport than to be driven to the airport by someone else. Conversely, shorter journeys are more associated with drop-off and taxi use.

Like passengers who travelled by car, trip purpose was shown to be strongly associated with taxi users. Compared with leisure passengers, business passengers were more likely to travel by taxi than by public transport (β= 1.724), which is also consistent with the findings in Section 6.5.1 (see Figure 6.6). As shown in the analysis in Section 6.5.4, flight time is significant for taxi users; passengers accessing the airport between 05:00 and 07:00 were more likely to travel by taxi than public transport (β= 1.043).

What is immediately apparent from the model outputs is that the situational and spatial characteristics associated with public transport use vary considerably from the other modes. One of the defining characteristics of public transport use is travel group size. Compared with passengers travelling in a group, passengers travelling alone were shown to be more likely to travel by public transport than by car (β= -1.877), drop-off (β= -0.613) or taxi (β= -1.160).

Similarly, carrying checked-in luggage (or not) was shown to be important in the decision to travel by public transport. Passengers *not* carrying checked-in luggage were more likely to travel by public transport than use a taxi (β = -1.489). Looking at it another way, this also implies that passengers who do have luggage with them are more likely to use a taxi. This supports research such as Kazda and Caves (2008), and Coogan et al. (2008) and the views of airport managers in the scoping study (Section 3.3.2).

Journey distance is a further factor that is associated with public transport use. Compared with taxi (β= -1.759) or drop-off (β= -1.752) users, passengers faced with a longer journey to the airport (≥1 hour drive) were more likely to travel by public transport.

The purpose of the multinomial logistic regression procedure was to develop a typology of surface access passengers using the personal, situational and spatial variables included in the model. This typology is summarised in Table 6.6.

Table 6.6 Typology of surface access passengers

Mode	Key characteristics
Car	Have access to a car Business passenger Accessing the airport at peak times (05:00-07:00) Flying on the outbound leg of their journey
Drop-off	Travelling a shorter distance to the airport Travelling from their home Have access to a car
Taxi	Travelling a shorter distance to the airport Business passenger Accessing the airport at peak times (05:00-07:00)
Public transport	Travelling alone Travelling without checked-in luggage Travel from areas further from the airport

From the model findings it can be posited that car users are more likely to have access to a car in the UK, be travelling on business and have to travel to the airport during peak hours (05:00-07:00) on the outbound leg of their journey. Passengers who are dropped-off are also likely to have access to a car, be starting their journey from home and travelling a shorter distance to the airport.

Taxi users are more likely to be business passengers, travelling to the airport in the early morning peak period from areas relatively close to the airport. In contrast, public transport users are more likely to be travelling alone, without checked-in luggage, and, in comparison with drop-off and taxi users, travelling from places further away from the airport.

6.8 Conclusions

Chapter 6 has addressed the third objective, “to assess the personal, situational, and spatial characteristics of passenger mode choice.” Initially, mode share statistics from the survey were reported in Section 6.2. Overall, 80% of passenger journeys were found to be by private vehicles, with drop-off (29.7%) representing the single largest group. This is significant given that drop-off journeys are considered to be the most environmentally and commercially damaging for the airport, as detailed in the literature review (Section 2.3.1) and interviews with airport managers (Section 3.3.1). Public transport journeys represented a fifth of trips in the survey (20%), of which the majority were by train. Relatively few journeys were made by bus or coach.

While mode share data was only available for departing passengers, information was sought from passengers on the outbound leg of their journey about whether they intended to leave the airport by the same mode on their return. Interestingly, 11.3% of these passengers stated that they intended to leave the airport by a different mode from the one they had used to access it. This provides an opportunity to develop new policies to encourage behavioural change concerning journeys from the airport, rather than purely focusing on journeys to it. Passengers travelling by taxi were found to be more likely to switch to public transport for their return journey than passengers who were dropped-off. Increasing the share of taxi users who leave the airport by public transport would have clear benefits in terms of reduced vehicle emissions and congestion on the airport site, even if the share of taxi journeys to the airport remained the same.

Mode share statistics are inevitably a crucial component of surface access management. But while they can be valuable for establishing the current situation at an airport and help identify trends and variations over a period of time, they are little use for determining the underlying motivators of these decisions. In essence, they show the results of the behaviour, rather than how it was reached, which is of only limited use in the context of trying to initiate behavioural change. Instead, for this it is necessary to consider the underlying factors motivating behaviour, as it is these that can yield valuable insights into how behaviour may be altered in the future.

Consequently, Section 6.3 sought to determine whether *"the factors motivating passenger mode choice vary for different modes (research question iv)."* Analysis was conducted on responses to an open ended question in the questionnaire which asked respondents to give the reasons why they had chosen to travel to the airport in the way that they had. Findings largely supported the notion that passenger mode choice is a product of perceptions about the relative cost, comfort and convenience of different modes, as posited by Ashford et al. 2013, although the role of these factors varied between modes. Comfort and convenience factors were important for car and taxi users, whereas the decision to be dropped-off was motivated primarily by cost considerations. As well as cost, comfort and convenience, journey speed and the availability of a mode were significant considerations for passenger travelling by public transport.

Clearly there are other factors that influence mode choice. From the literature and interviews with airport managers a number of personal, situational and spatial factors that can influence mode choice were identified. Consequently, analysis in Chapter 6 also sought to assess "*how the personal, situational and spatial characteristics of* *passenger surface access travel are expressed in terms of mode choice (research question v)."* Initially, the various personal, situational and spatial characteristics of mode choice were analysed using descriptive analytical techniques and GIS mapping in Section 6.4, 6.5 and 6.6.

This information was then used to help inform the next stage of analysis in Section 6.7, where multinomial logistic regression was used to develop a typology of surface access passengers based on their various personal, situational and spatial characteristics. This process proved valuable as it identified the various factors that influence mode choice. In particular, it showed that there are fairly clear distinctions between public transport users and private vehicle users in terms of their situational and spatial characteristics. Public transport users were shown to be strongly characterised by travelling alone, and were less likely to be carrying checked-in luggage with them. In comparison with drop-off and taxi users, passengers travelling by public transport were also more likely to be travelling from regions further from the airport.

In contrast, car users were found to be likely to have access to car, be travelling on business, accessing the airport early in the morning and flying on the outbound leg of their journey. Passengers who were dropped-off at the airport were also likely to have access to a car, but were more likely to be starting their journey from home and travelling a shorter distance to the airport. Taxi users were likely to be travelling for business purposes and accessing the airport in the early morning peak period. They were also likely to be travelling only a relatively short distance to the airport.

These findings provide important policy insights for decision makers, especially given the need for airports to develop strategies for reducing private vehicle trips and increasing public transport. Herein lies one of the main advantages of typologies, namely that they provide a basis for systematic comparisons to be made between various phenomena and create useful heuristics, even where the sources of information are incomplete or non-exhaustive (Smith, 2002).

However, a potential drawback of this approach is that typologies are largely descriptive, as opposed to predictive, in nature. In other words, while it may be possible to classify passengers based on their collective personal, situational and spatial characteristics, predicting how these people will likely behave in the future and identifying those with the greatest propensity to change their behaviour is more problematic. Also, focusing solely on personal, situational and spatial characteristics inevitably omits the role of a person’s attitudes and perceptions in the decision making process, which, as described in Chapter 4, is a fundamental part of travel behaviour.

Socio-psychological theories such as the Norm-Activation Theory (Schwartz, 1977) and Theory of Planned Behaviour (Ajzen, 1991) are well suited for use in a travel behaviour context as they identify the psychological antecedents of behaviour, and provide a precise operationalization of the various psychological constructs that inform these decisions. Through this it is then possible to detect how patterns of current behaviour could be altered in the future and identify those with the greatest potential for change.

Consequently, the following chapter employs two socio-psychological theories of attitude behaviour relations, namely the Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991), to evaluate the psychological determinants of decisions to travel to airports by alternative modes to private vehicles.

Chapter 7

Evaluating the psychological determinants of decisions to travel by alternative modes to private vehicles

7.1 Introduction

Chapter 7 seeks "to evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles (objective 4)". To achieve this, tests were conducted on two contrasting socio-psychological theories of attitude behaviour relations, the Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991).

As discussed in Chapter 4 (Section 4.2), both theoretical approaches have received empirical evidence in the literature for their application in a wide range of domains, including travel behaviour and mode choice. One of the reasons for choosing to investigate these two theories in the present research is because they take a different approach to behaviour. While the Theory of Planned Behaviour (Ajzen, 1991) emphasises the role of personal utility and self-interest in decision making, the Norm-Activation Theory (Schwartz, 1977) considers behaviour to be a function of a person's feelings of moral obligation to act in a certain way. Any recommendations for reducing private vehicle use to airports would therefore benefit from an understanding of whether *"decisions to travel by alternative modes to private vehicles are guided predominantly by moral, normative influences or by considerations of personal utility and self-interest (research question vi)."*

An alternative view also exists that recognises that travel behaviour and mode choice can have both self-interest and moral elements to it (see Section 4.5). This combined theoretical approach, which involves incorporating elements of both the Norm-Activation Theory and the Theory of Planned Behaviour, has received some support in the travel behaviour literature (for example, Bamberg et al., 2007; Gardner and Abraham, 2010). Subsequently, analysis in the chapter also seeks to ascertain whether *“a combined theoretical approach is more appropriate than either the Theory of Planned Behaviour or the Norm-Activation Theory in their original forms when explaining decisions to travel by alternative modes to airports” (research question vii).*

Furthermore, as discussed in Section 4.6, a number of studies have attempted to improve the predictive ability of the two theories by adding additional psychological constructs that were not present in either of the theories in their original forms (see for example, Anable, 2005; Heath and Gifford, 2002; Bamberg et al., 2007). Analysis is this chapter looks to build on and contribute to this growing body of research by assessing whether “*measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy are useful additional predictors of decisions to travel by alternative modes to airports (research question viii).”*

The analysis that follows is based on a sub-sample of 676 passengers from the passenger questionnaire survey who had access to private car in the UK. The reasons for this are explained in Section 7.2. A description of the method used in the chapter is then provided in Section 7.3. In Section 7.4, a test of the measurement model for the Norm-Activation Theory and the Theory of Planned Behaviour is reported. This was used to confirm that the various items included in the questionnaire were appropriate measures of their respective latent psychological constructs.

Analysis then proceeds in two stages. In Section 7.5, tests of the structural models of the Norm-Activation Theory and the Theory of Planned Behaviour are detailed. Following this, tests of two combined models containing elements of the Norm-Activation Theory, the Theory of Planned Behaviour and three additional constructs are reported in Section 7.6. Conclusions are provided at the end of the chapter in Section 7.7.

7.2 Defining the survey sub-sample

The analysis in this chapter is derived from the Manchester Airport passenger questionnaire survey (see Section 5.3). Only passengers who claimed to have regular access to a car in the UK were included in this stage of analysis. This reduced the sample size from 860 to 676 cases. This ensured that all respondents in the analysis, at least theoretically, had the same set of travel options available to them. If respondents without access to a car were also included it would have been difficult to determine to what extent theoretical performance (or lack of) was the result of the theoretical frameworks themselves, or simply an artefact of some respondents' limited choice set.

Table 7.1 compares the characteristics of the sub-sample (*n=676*) with the full sample (*n=860*). Generally, the sub-sample reflects the full sample closely, although there are some discrepancies. Because the sub-sample only includes passengers who have access to a car in the UK, inevitably UK residents and passengers starting their journey from home are overrepresented in the sub-sample in comparison with the full sample. Passengers travelling from home are almost inevitably flying on the outbound leg of their trip, and this group are also overrepresented in the sub-sample.

Table 7.1 Characteristics of the sub-sample and comparison with the full sample

		Sub-sample ***(n=676)***		**Full sample** ***(n=860)***	
		n	***%***	***n***	***%***
Mode	Public transport	94	13.9	172	20.0
	Private vehicles	582	86.1	688	80.0
Trip purpose	Leisure	524	77.5	662	77.0
	Business	152	22.5	198	23.0
Origin type	Home	559	82.7	625	72.7
	Other	117	17.3	235	27.3
Residence	UK	632	93.5	699	81.3
	Non-UK	44	6.5	161	18.7
Leg of trip	Outbound	624	92.3	694	80.7
	Return	52	7.7	166	19.3
Age	18-34	214	31.7	288	33.5
	35+	462	68.3	572	66.5
Gender	Male	340	50.3	433	50.3
	Female	336	49.7	427	49.7

Mode share in the sub-sample is fairly similar to the full sample. The relative share of passenger trip purpose, age and gender in the sub-sample are also reflective of the full sample. As the analysis is interested in determining the psychological factors associated with choosing alternative modes, mode choice was defined as passengers who used public transport (train and bus/coach) to travel to the airport and those who used private vehicles (car, taxi and drop-off).

7.3 Tests of theoretical frameworks using structural equation modelling

The theoretical frameworks were tested against the data using structural equation modelling in the computer programme Mplus (v6.11). A background to the reasons for using structural equation modelling has already been provided in Chapter 5

(Section 5.4.3). In essence, structural equation modelling is a highly flexible multivariate statistical modelling technique which can be used to test the structural validity of hypothesised theoretical models (Golob, 2003). The process involves simultaneous tests of the measurement and structural model to see to what extent the causal processes posited by the theoretical framework are consistent with the observed data. If the overall 'fit' of the model with the data is acceptable then the postulated relationships (and thus the theoretical framework overall) are accepted; if the fit is not acceptable, then the model is rejected (Byrne, 2012).

Like the multinomial logistic regression procedure employed in the previous chapter, here the independent variables (psychological constructs) were used to predict group membership (i.e. mode choice). Passengers were considered to have travelled either by public transport or by private vehicle (car, drop-off or taxi). As this is a categorical dependent variable a weighted least squares approach (WLS) was adopted, as suggested by Muthén and Muthén (2010).

7.4 Test of the measurement model

As discussed in Section 5.4.3, structural equation modelling consists of simultaneous tests of both the measurement model and structural model. The measurement model is a multivariate regression model that describes the relationships between a set of observed dependent variables and a set of continuous latent variables (Muthén and Muthén, 2010). While it is not commonly reported in the literature, it is important to test the measurement model as it essentially shows to what extent the various measures (for example, items in a questionnaire) are appropriate for the latent constructs they are posited as representing. Consequently, in this section a test of the measurement model is provided to show whether the attitude statements in the questionnaire are appropriate measures of their respective psychological constructs. Table 7.2 shows the mean scores and standard deviations for the various attitude statements (or item measures) included in the questionnaire, which were designed to ‘tap into’ the (latent) psychological constructs in the Norm-Activation Theory and the Theory of Planned Behaviour. As described in Chapter 4 (Section 4.3), psychological constructs in the Norm-Activation Theory (NAT) relate to awareness of consequences (AC), general problem awareness (GPA) and personal norm (PN). Constructs in the Theory of Planned Behaviour (TPB), on the other hand, relate to attitude (ATT), subjective norm (SN), perceived behavioural control (PBC) and intention (INT) (see Section 4.4). The mean, standard deviation and internal consistency (Cronbach’s α) of each psychological construct are also reported.

Statistics in Table 7.2 also relate to the three additional constructs included in the combined models (C1 and C2), which are addressed in Section 7.6. The additional constructs relate to; anticipated feelings of guilt (GLT), the extent to which people think that they will feel guilty if they perform an action; descriptive norm (DN), perceptions of what is ‘typical’ or ‘normal’ behaviour in a given situation; and efficacy (EFF), perceptions about what can be achieved. Some of the constructs apply to more than one theory/model, which is also indicated in Table 7.2.

Mean scores for psychological constructs were computed by calculating a respondent’s average score for the items measuring that construct. The average of these mean scores was then determined for the sample as a whole. This method was also used to establish the mean scores of individual item measures. As items were measured on a five point Likert scale, mean scores ranged from 1 to 5. Three items, att2, eff1 and dn1, were reverse coded prior to analysis. Congruent with the

Table 7.2 Means (M), standard deviation (SD) and internal consistencies (α) of constructs and item measures for the Norm-Activation Theory (NAT), Theory of Planned Behaviour (TPB) and two combined models (C1 and C2)

Construct	**NAT**	**TPB**	**C1**	**C2**	**Item**	**M**	**SD**	**α**
Awareness of Consequences (AC)	✓			✓				
					ac1	3.77	0.858	-
					ac2	2.88	0.988	-
					Overall	3.33	0.782	*0.988*
General Problem Awareness (GPA)	✓		✓	✓				
					gpa1	3.11	0.937	-
					gpa2	3.08	1.003	-
					Overall	*3.09*	*0.886*	*0.800*
Personal Norm (PN)	✓		✓	✓				
					pn1	2.08	0.972	-
					pn2	2.61	1.128	-
					Overall	*2.34*	*0.927*	*0.709*
Attitude (ATT)		✓	✓	✓				
					att1	3.04	1.288	-
					att2*	3.03	1.182	-
					att3	2.61	1.125	-
					Overall	*2.89*	*1.003*	*0.785*
Subjective Norm (SN)		✓	✓	✓				
					sn1	2.58	1.025	-
					sn2	2.41	1.054	-
					Overall	*2.50*	*0.970*	*0.844*
Perceived Behavioural Control (PBC)		✓	✓	✓				
					pbc1	2.49	1.328	-
					pbc2	2.82	1.415	-
					Overall	*2.65*	*1.286*	*0.862*
Intention (INT)		✓	✓	✓				
					int1	2.27	1.236	-
					int2	2.21	1.268	-
					Overall	*2.23*	*1.207*	*0.925*
Efficacy (EFF)^			✓					
					eff1*	2.45	1.044	-
					Overall	2.45	1.044	-
Descriptive Norm (DN)^			✓					
					dn1*	2.19	.984	-
					Overall	*2.19*	*.984*	-
Anticipated feelings of guilt (GLT)				✓				
					glt1	2.49	1.055	-
					glt2	2.48	0.995	-
					Overall	*2.48*	*0.951*	*0.839*

Note: * Item reverse code, ^ Cronbach's α not calculated as construct measured by a single item

Norm-Activation Theory and the Theory of Planned Behaviour, higher scores for psychological constructs and item measures indicate a greater likelihood of respondents choosing alternative modes to access the airport.

Considering constructs in the Norm-Activation Theory first, it can be seen that the mean score of the construct relating to respondent's awareness of the wider consequences of using their car to get to the airport (AC) was 3.33. The mean scores of the items that measured this construct, however, varied considerably (*"When I use my car to get to the airport, exhaust gases are emitted which have a negative effect on the global climate system"* = 3.77, and *"Using my car to get to the airport has a negative impact on other people"* = 2.88). This discrepancy is possibly due to the slight variation in the wording of the item measures, as the former referred to the impact on the *"global climate system"*, while the latter referred to *"other people."*

The mean score for items measuring the general awareness of the problem of car access to airports (GPA) was slightly lower than the previous construct (3.09). Mean scores for the two item measures were very similar ("*Private car access to airports is a major environmental problem"* = 3.11, and *"There is an urgent need to reduce private car use to airports"* = 3.08). Personal Norm (PN) to use public transport to access airports was fairly weak, with an overall mean score of only 2.34. Mean scores for the individual item measures were also low (*"Because of my own values, I feel a personal obligation to use public transport instead of my car to get to the airport"* = 2.08, and *"Regardless of what other people do, I feel morally obliged to use public transport instead of my car to get to the airport"* = 2.61).

Mean scores for items and constructs in the Theory of Planned Behaviour exhibit a similar pattern to those in the Norm-Activation Theory. With the exception of two items, mean scores for item measures in the Theory of Planned Behaviour were all less than three. The two items with mean scores higher than three related to two measures of respondent attitudes towards using public transport to access the airport, *"For me, using public transport to get to Manchester Airport would be good"* = 3.04, and *"Using public transport to get to Manchester Airport would be unpleasant for me"* = 3.03 (reverse coded). The low mean scores for items measuring subjective norm (SN), *"People who are important to me would think I should use public transport to get to Manchester Airport"* = 2.58, and *"I think people who are important to me would want me to use public transport to get to Manchester Airport"* = 2.41, suggest that respondents generally do not feel a social expectation to use public transport to travel to Manchester Airport. Similarly, low mean scores for items measuring perceived behavioural control (PBC) suggests that passengers consider using public transport to access the airport to be fairly difficult (*"For me, using public transport to get to Manchester Airport would be easy"* = 2.49, and *"I am confident that I could easily get to Manchester Airport by public transport"* = 2.82). Perhaps as a consequence of this, intention to use public transport to travel to Manchester Airport in the future (INT) is also fairly weak, with an overall mean score of 2.23.

Three additional constructs used in the combined models are also included in Table 7.2. The first additional construct, efficacy (EFF), was measured by the single item *"If I use public transport to get to the airport it will not make a difference because others will continue to use their private cars".* The mean score (2.45) for this item (and thus the construct overall), was similar to items included in the Norm-Activation Theory and Theory of Planned Behaviour. This suggests that respondents generally feel that their own behaviour would have little impact on increasing public transport use to airports because others would continue to use their cars regardless.

The second additional construct, descriptive norm (DN), was designed to measure perceptions of how the majority of other people behave. As addressed in Chapter 4 (Section 4.6), it is considered that people are motivated to behave in a way that is congruent with the perceived behaviour of others. Passengers were asked to estimate how frequently people they knew used their private cars to get to the airport *(Always, Often, Sometimes, Rarely, Never).* Once the pooled responses had been reverse coded, the mean score for descriptive norm was found to be 2.19, which suggests that respondents generally felt that people they knew often used their car to get to the airport.

The third additional construct related to anticipated feelings of guilt if one were to always use their car to get to the airport (GLT). The mean scores for the two items measuring it (2.49 and 2.48) were fairly low *("I would feel guilty if I always used my car to get to the airport"* = 2.49, and *"Considering the environmental impacts of car use, I would feel guilty about using my car to get to the airport"* = 2.48). This indicates that passengers generally do not think they would feel guilty if they were to always use their car to get to the airport.

Internal consistencies (Cronbach's α) were also calculated for each of the psychological constructs included in the models. Internal consistency refers to how closely related a set of items are as a group. Cronbach's alpha is commonly expressed as a function of the number of items included in the test and the average correlation among the items. It can be summarised with the following formula:

$$\alpha = \frac{k}{k-1}\frac{(1-\Sigma s_i^2)}{s_T^2}$$

Source: Bland and Altman, 1997

Where k is the number of items, s_i^2 is the variance on the ith item and s_T^2 is the variance of the total score formed by summing (Σ) all of the items (Bland and Altman, 1997). If the threshold of acceptability for Cronbach's α is considered as α ≥ 0.7, all constructs in Table 7.2 have a sufficient internal consistency, apart from awareness of consequences (α= 0.598). The reason for the lower internal consistency of AC is likely to be due to the disparity in the mean scores of the two item measures, which in turn is possibly due to the wording of the items, as discussed. While acknowledging this, it was felt that retaining these two items for the purpose of further analysis was justified. While an internal consistency of greater than 0.7 would be preferable, it was felt that it was not sufficiently low to warrant exclusion from the analysis. Other studies have applied a lower threshold of α ≥ 0.5 (for example, see Hunecke et al., 2001; Bamberg et al., 2007), so here AC was retained. Cronbach's α was not calculated for EFF or DN as these were only measured by single items.

In addition to assessing how closely related the items are as a group, it is also important to confirm the suitability of the individual item measures in relation to the psychological constructs they are designed to measure. This is the measurement model in structural equation modelling, as addressed in Section 5.4.3. The process is similar to (although not entirely the same as) a confirmatory factor analysis, as it seeks to test various hypothesised (i.e. pre-determined) relationships. Unlike exploratory factor analysis (see Section 8.2.1), the purpose here is not to test for the presence and structure of underlying latent factors, but rather to confirm (or reject) the suitability of the item measures in the questionnaire.

The test of the measurement model is shown in Table 7.3. Statistics refer to factor loadings (λ), with results closer to 1.0 indicating a stronger correlation between the item and the construct it measures. Ideally, items will load strongly (λ≥.500) onto the construct to which they are supposed to refer, and weakly (λ<.500) onto the remaining constructs. For ease of interpretation, factor loadings λ≥.500 (indicating a stronger correlation) are shown in dark font, while factor loadings λ<.500 (indicating a weaker correlation) are shown in feint font.

Generally speaking, items load heavily on one construct (λ≥.500) and weakly on the other constructs (λ<.500), indicating that the items only measure the construct to which they are supposed to refer. For example, Construct 1 clearly relates to 'perceived behavioural control' (PBC) given that the two item measures (*pbc1 and pbc2*) load heavily on it (.866 and .880), while all other items load weakly on it. The only exceptions to this are *'ac2'* and *'att1'*. Table 7.3 shows that the measure *'ac2'* loads moderately on Construct 7 (.500) and on Construct 10 (.469), which appear to relate to 'awareness of consequences' (AC) and 'general problem awareness' (GPA), respectively. Although ideally the item would have loaded more strongly on the construct for AC and weaker on the construct relating to GPA, the similarity is not entirely surprising given that two constructs are posited as correlating with each other in the Norm-Activation Theory.

Table 7.3 Test of the measurement model

	Construct									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Awareness of Consequences (AC)										
ac1	.058	.032	.097	-.004	.054	.111	.929	.013	.024	.174
ac2	.127	-.456	.177	.032	.206	-.104	.500	.087	-.008	.469
General Problem Awareness (GPA)										
gpa1	.129	-.031	.124	.002	.086	.118	.097	.016	.015	.870
gpa2	.108	.047	.149	.046	.130	.053	.130	.090	.014	.863
Personal Norm (PN)										
pn1	.114	-.139	.139	.109	.876	.111	.014	.055	.064	.109
pn2	.292	.183	.156	.165	.756	.094	.123	.116	.001	.165
Attitude (ATT)										
att1	.173	.439	.457	.200	.186	.503	.170	.097	.014	.200
att2	.379	.100	.105	.138	.139	.794	.078	.093	.029	.138
att3	.483	-.045	.316	.063	.135	.651	.071	.062	-.013	.063
Subjective Norm (SN)										
sn1	.286	.126	.801	.242	.197	.058	.119	.032	.036	.242
sn2	.343	-.137	.799	.127	.125	.220	.058	.079	.033	.127
Perceived Behavioural Control (PBC)										
pbc1	.866	.076	.153	.120	.119	.160	.027	-.014	.074	.120
pbc2	.880	.095	.055	.058	.141	.087	.028	-.033	.045	.058
Intention (INT)										
int1	.353	.766	-.133	.126	.104	.250	.059	.099	.074	.126
int2	.381	.733	-.144	.095	.119	.279	.052	.092	.055	.095
Efficacy (EFF)										
eff1	.057	.001	.082	.013	.124	..092	.028	.974	.026	.095
Descriptive Norm (DN)										
dn1	.129	.003	.045	.007	.053	0.15	.021	.025	.987	.021
Anticipated Feelings of Guilt (GLT)										
glt1	.012	-.033	.009	.929	-.022	.019	.036	-.003	.035	.011
glt2	.010	-.033	.021	.926	.052	-.018	-.032	.017	-028	.034

Factor loadings ≥.500 shown in dark font. Factor loadings <.500 shown in feint font.

Similarly, *'att1'* loads moderately on Construct 6 (.503), Construct 2 (.439) and Construct 3 (.457). Given the way that other items load on these factors it would appear that Factor 6 relates to the 'attitude' (ATT), Factor 2 relates to 'intention' (INT) and Factor 3 relates to 'subjective norm' (SN). The way in which *'att1'* loads moderately on each of these factors is possibly explained by the way in which the three constructs are theoretically linked in the Theory of Planned Behaviour. As detailed in Section 4.4, attitude correlates with subjective norm, and is a direct predictor of intention, in the Theory of Planned Behaviour.

Overall, the test of the measurement model shows that the various attitude statements (or items measures) are appropriate measures of the psychological constructs under study. Given this confirmation, it is appropriate to proceed to the next stage, which tests the structural models of the Norm-Activation Theory and the Theory of Planned Behaviour.

7.5 Tests of the structural model of the Norm-Activation Theory and the Theory of Planned Behaviour

In this section, tests of the structural models of the Norm-Activation Theory and the Theory of Planned Behaviour are reported. The two models are then compared in terms of their ability to explain the use of alternative modes in order to determine whether *"decisions to travel by alternative modes to private vehicles are guided predominantly by moral and normative influences or by considerations of personal utility and self-interest (research question vi)."*

7.5.1 Norm-Activation Theory (NAT)

As proposed by Schwartz (1977), the theoretical framework of the Norm-Activation Theory was specified with the dependent variable (public transport use) regressed on 'personal norm'. In turn, 'personal norm' was regressed on the constructs 'awareness of consequences' and 'general problem awareness'.

Figure 7.1 shows the results of the test of the structural model of the Norm-Activation Theory. Reported statistics are standardised path coefficients (β), explained variances (R^2) and Pearson's Correlation Coefficients (r). As discussed in Chapter 5 (Section 5.4.3), standardised path coefficients (represented by a one way arrow) indicate the impact of one variable on another. The size of the effect is interpreted according to Cohen's (1988) guidelines (see Section 5.4.3).

≥0.10 - <0.30 represents a small effect

≥0.30 - <0.50 represents a medium sized effect

≥0.50 represents a large effect

The explained variance (R^2) of a construct represents the proportion of variance that can be explained by the constructs that are related to it. Essentially it shows to what extent the changes in one construct are the direct result of changes in the other constructs in the model, and not some external influence.

Analysis shows that the causal structure underlying the Norm-Activation Theory is supported by the data. All structural paths proposed by the model show a positive and significant relationship (p<0.05). Self-reported feelings of personal moral obligation to use public transport instead of the car (personal norm) show a medium to large association with the decision to use alternative modes (*β*=0.499, *p*=0.000). This is similar to the moderate effect of personal norm on willingness to reduce car use in Sweden (*β*=0.44), as found by Nordlund and Garvill (2003). Given the relatively low mean scores for items measuring personal norm in the survey (see Table 7.2), however, the size of the effect personal norm is shown to have on public transport use was slightly unexpected.

Overall, personal norm is shown to explain 25% of the variance in public transport use (R^2=0.249). The central proposition of the Norm-Activation Theory, that behaviour is the direct result of personal feelings of moral obligation (personal norm), is thus supported. In this case the amount of explained variance attributable to personal norm compares favourably with other studies. For example, in the study of travel behaviour of German university students, Bamberg and Schmidt (2003) found that personal norm explained 14% of the variance in mode choice.

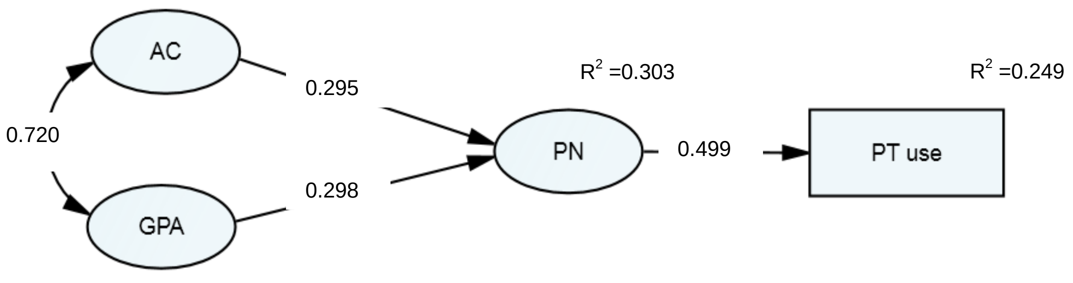


Figure 7.1 Structural model of the Norm-Activation Theory with standardised path coefficients indicating the strength of predicted relationship and explained variances. Variables are 'Awareness of Consequences' (AC), 'General Problem Awareness' (GPA), Personal Norm (PN) and 'Public Transport use' (PT use). All structural paths are significant ($p<0.05$). Explained variances (as a percentage) are PT use = 25%, and PN = 30%. Model fit indices: RMSEA = 0.048; CFI = 0.985; TLI = 0.971; WRMR = 0.567

In turn, 30% of the variance in personal norm is explained by the constructs 'awareness of consequences' and 'general problem awareness' (R^2=0.303). Both constructs exhibit a small to medium sized effect on personal norm (β=0.295, p=0.002, and β=0.298, p=0.001, respectively). Awareness of consequences and general problem awareness were also found to strongly correlate with each other (r=0.720, p=0.000), as conceptualised by Schwartz (1977). This suggests that the more a respondent perceives car access to airports to be a problem, the more they perceive their own car use to have negative environmental consequences (and vice versa). Model fit indices indicate that the model fits the data well (RMSEA=0.048; CFI=0.985; TLI=0.971; WRMR=0.567). Unfortunately, it is harder to compare model fit statistics with existing research because a variety of different fit statistics are reported. Nordlund and Garvill (2003) however, reported an RMSEA statistic of 0.075 for their test of the Norm-Activation Theory for mode choice in Sweden, which is comparable with this study.

7.5.2 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour was then tested against the data. According to the theoretical framework proposed by Ajzen (1991), the dependent variable of public transport use was regressed on behavioural 'intention' and on 'perceived behavioural control'. The direct link between 'perceived behavioural control' and public transport use relates to Ajzen's (1991) assertion that in some instances 'perceived behavioural control' can have a direct influence on behaviour. 'Intention' was then regressed on the constructs 'attitude', 'subjective norm' and 'perceived behavioural control'.

The result of the test of the structural model of the Theory of Planned Behaviour is shown in Figure 7.2. Again, reported statistics are standardised path coefficients (*β*), explained variances (R^2) and Pearson's Correlation Coefficients (r).

The causal structure underlying the Theory of Planned Behaviour is supported by the data with all structural paths in the model showing a positive and significant relationship ($p<0.05$). Intention to use public transport to access Manchester Airport in the future shows a strong association with actual public transport use ($\beta=0.640$, $p=0.000$). The association between behavioural intention and mode choice is similar to that reported by Bamberg et al. (2003), who also reported a strong association between intention and self-reported car use ($\beta=0.60$). The strength of the association between perceived behavioural control and public transport use, however, is shown to be considerably weaker than intention ($\beta=0.236$, $p=0.013$).

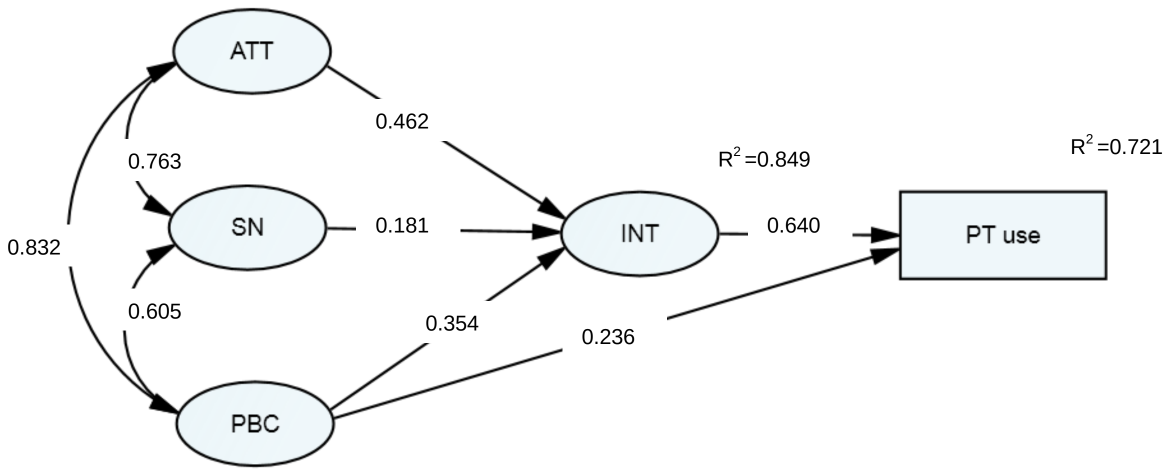


Figure 7.2 Structural model of the Theory of Planned Behaviour with standardised path coefficients indicating the strength of predicted relation and explained variances. Variables are 'Attitude' (ATT), 'Subjective Norm' (SN), 'Perceived Behavioural Control (PBC), 'Intention' (INT) and 'Public Transport use' (PT use). All structural paths are significant (p<0.05). Explained variances (as a percentage) are PT use = 72% and Intention = 85%. Model fit indices: RMSEA = 0.106; CFI = 0.952; TLI = 0.923; WRMR = 0.523

Together, intention and perceived behavioural control explained 72% (R^2=0.721) of the variance in public transport use. This was higher than expected, given that other similar studies have reported more modest results. For example, in their study of mode choice in two German agglomerations, Bamberg et al. (2007) reported explained variances of 53% (R^2=0.53) and 20% (R^2=0.20) for mode choice.

Given the relatively weak association of perceived behavioural control with public transport use, the model was run again but this time omitting this link. This was undertaken to see whether perceived behavioural control added to the explained variance of public transport use over and above intention on its own. It was subsequently found that intention alone explains 73% (R^2=0.728) of public transport use. In other words, in this case intention is actually a better predictor of public transport use when it acts as the sole predictor.

Overall, attitude, subjective norm and perceived behavioural control explained 85% (R^2=0.849) of the variance in intention which strongly supports the theoretical framework of the model, as posited by Ajzen (1991). Attitude towards using public transport to access Manchester Airport was the strongest predictor of intention to use public transport in the future (β=0.462, p=0.000), followed by perceived behavioural control (β=0.354, p=0.000). This also indicated that perceived behavioural control is better utilised as a predictor of intention, rather than as a direct predictor of mode choice.

In contrast, subjective norm was shown to be a weak predictor of intention (β=0.181, p=0.001), indicating that perceived social pressure has little influence on mode choice (given that intention in turn was shown to be strongly associated with behaviour). As conceptualised by the framework of the theory, attitude, subjective norm and perceived behavioural control are also all strongly correlated with each other. Model fit indices indicate that the model fits the empirical data well in three out of the four fit statistics (RMSEA=0.106; CFI=0.952; TLI=0.923; WRMR=0.523), although the RMSEA statistic compares slightly less favourably in comparison with the Norm-Activation Theory.

Testing the Norm-Activation Theory and the Theory of Planned Behaviour sought to address whether the decision to travel to the airport by alternative modes to private vehicle modes was predominantly driven by personal moral considerations, as proposed by the Norm-Activation Theory, or by considerations of personal utility and self-interest, as posited by the Theory of Planned Behaviour. Tests of the respective theories showed that the concept of personal norm in the Norm-Activation Theory explained 25% (R^2=0.249) of the variance in public transport use. In comparison, the concepts of behavioural intention and perceived behavioural control, from the Theory of Planned Behaviour, explained 72% (R^2=0.721) of the variance in public transport use. Further analysis then found that intention alone explained slightly more variance in public transport use (73%, R^2=0.728) when perceived behavioural control was removed as a direct predictor of behaviour.

It can therefore be determined that travelling by alternative modes to private vehicles is a decision motivated primarily by considerations of personal utility maximisation and self-interest, rather than feelings of personal moral obligation. The extent to which intention explained the variance in public transport use was higher than expected, and in some cases was notably higher than in other similar studies (for example, Bamberg et al., 2007). It could, therefore, also be suggested that surface access travel is more of a personally guided, selfish form of travel behaviour than other types of journeys. A possible explanation for this is that the various surface access requirements and characteristics of passengers (Section 2.3.1), as well as the specific characteristics associated with public transport users (Chapter 6) translate into a more selfish approach to mode choice.

This is not to say that personal morals do not play any role in surface access mode choice. In the test of the Norm-Activation Theory, 25% of the variance in public transport use was explained by personal norm (R^2=0.249). Although it does not appear to play as significant a role as intention in the decision making process, the results suggest that morals do play a role to some degree. It is possible that the role of personal norm as an antecedent of mode choice is more of an indirect one, with its influence being mediated by other constructs. Subsequently, there is a case for adopting a combined theoretical approach incorporating elements of both theories. As a result, in the following section the structural models of two combined models are tested.

7.6 Tests of two combined models

In this section tests of the structural models of two combined models are reported. The conceptual frameworks of the combined models reflect similar models proposed by Bamberg et al. (2007), and Gardner and Abraham (2010), which were discussed in Chapter 4 (Section 4.5). As well as incorporating elements of both the Norm-Activation Theory and the Theory of Planned Behaviour, the combined models included three additional constructs; anticipated feelings of guilt, descriptive norm, and efficacy. Previous studies have suggested that these constructs influence travel behaviour (see Section 4.6), and they were therefore tested here in the context of surface access travel.

Consequently, the chapter seeks to assess whether *"a combined theoretical approach is more appropriate than either the Theory of Planned Behaviour or the Norm-Activation Theory in their original forms when explaining decisions to travel by alternative modes to airports (research question vii),"* and determine if *"measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy are useful additional predictors of decisions to travel by alternative modes to airports (research question viii)."*

7.6.1 Test of the first combined model (C1)

The theoretical framework of the first combined model was specified in accordance with the model proposed by Gardner and Abraham (2010), who applied it in the context of predicting car use in a UK city. The model includes all of the constructs from the Theory of Planned Behaviour as well as 'personal norm' and 'general problem awareness' from the Norm-Activation Theory. In addition, the model also includes two extra constructs; 'descriptive norm' and 'efficacy'. As discussed in Chapter 4 (Section 4.6), descriptive norm relates to what is perceived to be typical or normal behaviour, or what most people do in a given context. Efficacy relates to individual perceptions of what can be done or achieved in a given situation. In this study it was framed in the context of people's perceptions of what impact their own behaviour could have on airport surface access issues.

According to the framework of the model, public transport use was regressed on 'intention'. 'Intention' was then regressed on 'perceived behavioural control', 'attitude', 'subjective norm', 'descriptive norm' and 'personal norm'. In turn, 'attitude' and 'personal norm' were both regressed on 'efficacy' and 'general problem awareness'. The test of the first combined model is shown in Figure 7.3. Reported statistics are standardised path coefficients (β) and explained variances (R^2).

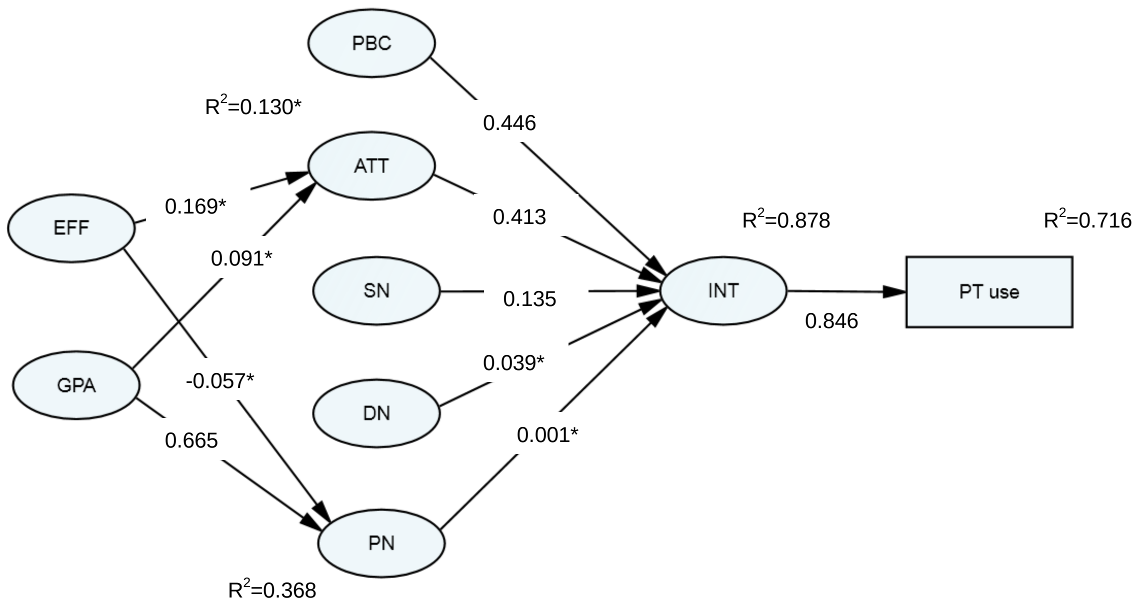


Figure 7.3 Structural model of the first combined model, with standardised path coefficients indicating the strength of predicted relation and explained variances. Variables are 'Efficacy' (EFF), 'General Problem Awareness' (GPA), Perceived Behavioural Control (PBC), 'Subjective Norm' (SN), 'Descriptive Norm' (DN), 'Attitude' (ATT), 'Personal Norm' (PN), 'Intention' (INT) and 'Public Transport use' (PT use). * = Not significant at $p<0.05$. Explained variances (as a percentage) are PT use = 72%, Intention = 88%, Attitude = 13% and Personal Norm = 37%. Model fit indices: RMSEA = 0.106; CFI = 0.883; TLI = 0.846; WRMR = 1.283

The results of the structural equation modelling procedure indicate that intention has a strong association with public transport use (β=0.846, p=0.000), and that it explains 72% (R^2=0.716) of the variance in behaviour. This statistic is similar to the amount of variance explained by intention in the Theory of Planned Behaviour, which was to be expected given that this part of the two models is the same (minus the direct link between perceived behavioural and behaviour).

Overall, perceived behavioural control, attitude, subjective norm, descriptive norm and personal norm explained 88% (R^2=0.878) of the variance in intention. While this supports the theoretical framework of the model, the performance of the five constructs varies considerably. The role of attitude, perceived behavioural control and subjective norm as predictors of intention in the composite model is similar to the Theory of Planned Behaviour. Perceived behavioural control and attitude both show moderate associations with intention (β=0.446, p=0.000, and β=0.413, p=0.000, respectively), whereas subjective norm shows only a weak association with it (β=0.135, p=0.030). The remaining two constructs perform poorly as predictors of intention, however. The association between ‘descriptive norm’ and ‘intention’ was negligible and not statistically significant. The role of personal norm as a predictor of intention was also shown to be weak and not statistically significant. This indicates that moral obligations have very little (if any) influence on the formation of behavioural intentions. This was unexpected, as personal norm was shown to have a medium sized effect on public transport use in the test of the Norm-Activation Theory (see Section 7.5.1), so it could have been expected that there is at least some association between personal norm and intention.

The model findings also do not support the use of efficacy and general problem awareness as predictors of attitude, as both show weak and statistically insignificant associations with it. However, general problem awareness *is* shown to be a strong predictor of personal norm (β=0.665, p=0.000). In contrast, the role of efficacy as a predictor of personal norm is not statistically significant. Together, efficacy and general problem awareness explain 37% (R^2=0.368) of the variance in personal norm, although it is fairly safe to assume that this is almost solely down to the role played by the latter.

Model fit indices suggest that the model does not fit the data well (RMSEA=0.106; CFI=0.883; TLI=0.846; WRMR=1.283). The poor model fit is most likely the result of the poor performance of efficacy, descriptive norm, personal norm and, to a lesser extent, general problem awareness. If any post hoc modifications were to be conducted on the model to improve model fit the specification of these constructs would be the obvious place to start. Given that personal norm was not found to significantly affect intention, there is perhaps a case for re-specifying it as an additional direct predictor of behaviour along with intention. Model fit indices were not reported in the study by Gardner and Abraham (2010), so unfortunately model fit comparisons cannot be made.

Similarly, efficacy may be better specified as a predictor of perceived behavioural control, rather than intention, as from a theoretical perspective they appear to share several similarities (i.e. the difficulty or ease with which something could be achieved). It is possible that descriptive norm may perform better when mediated through subjective norm, rather than acting as a direct predictor of intention, given that perceptions of what others do (descriptive norm) may be linked to perceptions of what others think you should do (subjective norm). While the purpose of the analysis was to test existing models rather than propose new ones, investigating these links would perhaps be a possible avenue for future research.

7.6.2 Test of the second combined model (C2)

The theoretical framework of the second combined model was specified in accordance with the model originally proposed by Bamberg et al. (2007). Similar models have since been used in other areas of travel behaviour research (for example, see Klöckner and Blöbaum, 2010). The model incorporates all of the constructs included in the original versions of the Norm-Activation Theory and the Theory of Planned Behaviour as well as an extra construct pertaining to respondents anticipated feelings of guilt. This was framed in the context of anticipated feelings of guilt if the respondent were to always use their car to get to the airport in the future, rather than use public transport.

According to the theoretical framework of the model, public transport use was regressed on ‘intention’. ‘Intention’ was then regressed on ‘perceived behavioural control’, ‘attitude’, ‘personal norm’ and ‘anticipated feelings of guilt’. ‘Perceived behavioural control’ and ‘attitude’ were regressed on ‘general problem awareness’ and ‘subjective norm’. ‘Personal norm’ was regressed on ‘subjective norm’ and ‘anticipated feelings of guilt’. In turn, ‘anticipated feelings of guilt’ were regressed on ‘subjective norm’ and ‘general problem awareness’. Finally, ‘subjective norm’ was regressed on ‘awareness of consequences’. In addition, the model posits that ‘perceived behavioural control’ correlates with ‘attitude’, ‘attitude’ correlates with ‘personal norm’, and ‘subjective norm’ correlates with ‘general problem awareness’. The test of the model is shown in Figure 7.4. Reported statistics are standardised path coefficients (β), explained variances (R^2) and Pearson’s Correlation Coefficients (r).

As shown in Figure 7.4, there is a strong association between intention to use public transport in the future and public transport use (β=0.848, p=0.000). Intention explains 73% (R^2=0.728) of the variance in public transport use, the same as in the Theory of Planned Behaviour (minus the direct link with perceived behavioural). Again, this was to be expected as this part of the model is the same as the Theory of

Planned Behaviour (minus the direct link between perceived behavioural and behaviour).

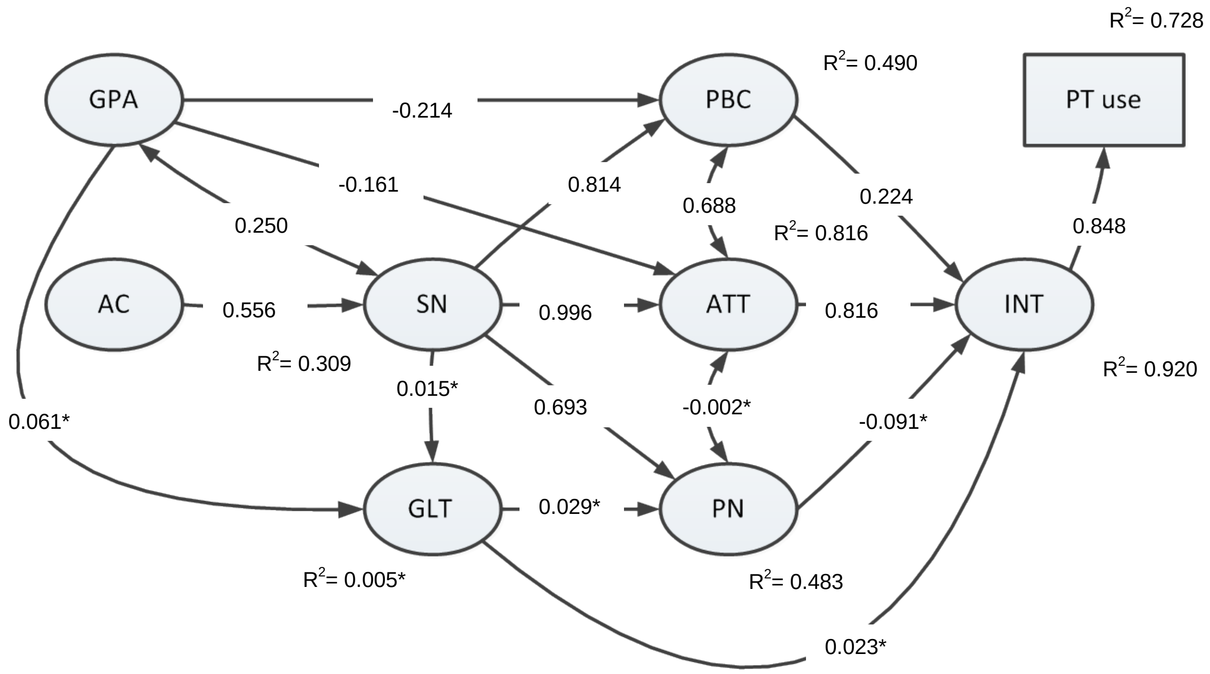


Figure 7.4 Structural model of the second combined model, with standardised path coefficients indicating the strength of predicted relation and explained variances. Variables are ‘General Problem Awareness’ (GPA), ‘Awareness of Consequences’ (AC), ‘Subjective Norm’ (SN), ‘Anticipated Feelings of Guilt’ (GLT), ‘Perceived Behavioural Control’ (PBC), ‘Attitude’ (ATT), ‘Personal Norm’ (PN), ‘Intention’ (INT) and ‘Public Transport use’ (PT use). *= Not significant at p<0.05. Explained variances (as a percentage) are PT use = 73%, INT = 92%, PBC = 49%, ATT = 82%, PN = 48%, SN = 31% and GLT = 0.01%. Model fit indices: RMSEA = 0.048; CFI = 0.977; TLI = 0.971; WRMR = 0.645

In the model, intention is predicted by four constructs; attitude, perceived behavioural control, personal norm and anticipated feelings of guilt. Together they explain 92% of the variance in intention to use public transport. This suggests that intention is almost entirely explained by these four constructs. Attitude shows a strong association with intention (β=0.816, p=0.000), whereas perceived behavioural control shows a weaker association with it (β=0.224, p=0.034). The strength of the association between attitude and intention is much higher here than in either the Theory of Planned Behaviour in its original form or in the first combined model. Unlike the other two models, here subjective norm is not used as a direct predictor of intention. It would seem that in this instance at least the performance of attitude as a predictor of intention improves if subjective norm is removed.

Like in the first combined model, the association between personal norm and intention here is insignificant. Anticipated feelings of guilt are also shown not to have a statistically significant impact on either personal norm or behavioural intention. This indicates fairly clearly that feelings of guilt or remorse play very little, if any, role in decisions about how to travel to the airport. As personal norm and anticipated feeling of guilt performed poorly in the model, the model was run again but this time omitting the links between intention, personal norm and anticipated feelings of guilt. It was found that attitude and perceived behavioural control alone explained 90% (R^2=0.904) of the variance in intention, which was only slightly lower than when it was predicted by all four of the constructs.

In the first combined model subjective norm was utilised as a direct predictor of intention. Here, the influence of subjective norm on intention is mediated through its effect on perceived behavioural control, attitude, personal norm and anticipated feelings of guilt. As can be seen, subjective norm shows a strong association with perceived behavioural control (β=0.814, p=0.000), attitude (β=0.996, p=0.000) and personal norm (β=0.693, p=0.000). This suggests that in this context subjective norm may be better utilised as a predictor of these three constructs, rather than as a direct predictor of intention.

The association of subjective norm with anticipated feelings of guilt, however, was not statistically significant. Subjective norm and general problem awareness explained 49% (R^2=0.490) and 82% (R^2=0.816) of the variance in perceived behavioural control and attitude, respectively. Subjective norm and anticipated feelings of guilt explained 48% (R^2 =0.483) of the variance in personal norm, although this should be treated with caution given the statistically insignificant association of anticipated feelings of guilt with personal norm. In turn, 31% (R^2=0.309) of the variance in subjective norm was explained by awareness of consequences, which shows a strong association with it (β=0.566, p=0.000).

The concept of general problem awareness performs poorly in the model. It shows a weak negative association with both perceived behavioural control (β=-0.214, p=0.001) and attitude (β=-0.161, p=0.020). Further, the postulated association of general problem awareness with anticipated feelings of guilt is weak and statistically insignificant. General problem awareness is also weakly correlated with subjective norm (r= 0.250, p=0.000).

Model fit statistics for the second combined model are better than for the first one, and indicate that the model fits the data well (RMSEA = 0.048; CFI = 0.977; TLI = 0.971; WRMR = 0.645). The model fit indices also compare well with those reported in the original study by Bamberg et al. (2007), although it was not possible to compare TLI and WRMR statistics as these were not reported (RMSEA = 0.039 and 0.039; CFI= 0.98 and 0.96). Despite the relatively poor performance of personal norm, anticipated feelings of guilt, and general problem awareness in the model, the overall fit of the model was better than for the first combined model and both the Theory of Planned Behaviour and the Norm-Activation Model in their original forms.

Testing the combined models sought to address two questions. The first of these related to ascertaining whether *“a combined theoretical approach is more appropriate than either the Theory of Planned Behaviour or the Norm-Activation Theory in their original forms when explaining decisions to travel by alternative modes to airports (research question vii).”* Results from the tests of the two combined models conducted are inconclusive in this regard. Generally speaking, while the second combined model (C2) performed well, the test of the first combined model (C1) was less successful.

Model fit indices and reported statistics pertaining to individual psychological constructs in the second combined model compared favourably with the Norm-Activation Theory and the Theory of Planned Behaviour in their original forms and the first combined model. Findings were also favourable in comparison with those reported by Bamberg et al. (2007), who first proposed and tested the model in the context of mode choice in Germany. While these findings lend support to the adoption of a combined theoretical approach in the future, it is difficult to advocate such a course of action on the basis of the model fit statistics alone, given that normative elements, such as anticipated feelings of guilt’, ‘general problem awareness’ and ‘personal norm’, generally did not perform well in the model. Consequently, there is a case for re-assessing the role or these normative elements if future studies were to adopt a similar combined theoretical approach (at least in the context of surface access context).

The notable exception to this is subjective norm, which was shown to be more effective as a predictor of attitude, perceived behavioural control and personal norm in the combined model than as a direct predictor of intention (as in the Theory of

Planned Behaviour). In this sense the second combined model is a significant improvement on the Theory of Planned Behaviour in its original form.

While elements of the model proposed by Bamberg et al. (2007) outperformed the Theory of Planned Behaviour, the combined model proposed by Gardner and Abraham (2010) compared far less favourably. It would seem that the role of efficacy, descriptive norm and personal norm were not specified correctly. This is not to say that the findings reflect poorly on the model itself or the underlying theory, but merely that in its current form it is not well suited for application in a surface access context.

Testing the combined models also sought to determine if *"measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy are useful additional predictors of decisions to travel by alternative modes to airports (research question viii)."* The findings from the model tests show that they are not useful additional predictors of mode choice. In the first combined model, efficacy and descriptive norm both performed poorly. The influence of descriptive norm on intention was found to be negligible and not statistically significant. The influence of efficacy on intention was posited as being via its role as a predictor of attitude and personal norm. However, its association with both attitude and personal norm was found to be statistically insignificant.

This suggests that decisions to travel by alternative modes to private vehicles for airport journeys are not influenced by feelings about what could be achieved (efficacy), or perceptions of what the 'normal' or 'typical' behaviour is. In the case of the latter, it is possible that perceptions about the behaviour of others are less important than one's own behaviour. To put it another way, given that surface access mode choice was shown to be motivated primarily by personal considerations and self-interest in Section 7.5, perceptions of what others do is perhaps less important in a surface access context than it might be in other domains.

Similarly, in the second combined model Bamberg et al. (2007) included a measure pertaining to anticipated feelings of guilt if the passenger were always to use their car to travel to the airport. It was posited as having a direct influence on intention and personal norm. However, in both instances these effects were shown to be negligible and not statistically significant. It would seem that surface access mode choice is not a decision that is likely to elicit feelings of guilt among passengers.

7.7 Conclusions

Chapter 7 has addressed the fourth objective, “to evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles.” Based on a sub-sample of the Manchester Airport passenger questionnaire survey, structural equation modelling was used to test the theoretical framework of the Norm-Activation Theory and the Theory of Planned Behaviour. Overall, the decision to travel by modes other than private vehicles was found to be a choice motivated primarily by considerations of personal utility maximisation and self-interest (Theory of Planned Behaviour) rather than by feelings of personal moral obligation (Norm-Activation Theory).

The theoretical frameworks of two combined models were then tested in accordance with similar models proposed by Gardner and Abraham (2010) and Bamberg et al. (2007). These combined models incorporated elements from both major theories and three additional constructs relating to anticipated feelings of guilt, descriptive norm, and efficacy. The purpose of this was to test whether combined theoretical approaches were more appropriate than either the Theory of Planned Behaviour or Norm-Activation Theory in their original form, and to test the ability of the three additional constructs.

The second combined model was shown to fit the data well and represented an improvement over the two original theories and the other combined model. However, the three additional constructs all performed poorly and added little to their respective models. While this is not to say that such constructs are not appropriate in a travel behaviour context *per se*, this research shows that their value is limited to specific contexts and situations.

Evaluating the psychological determinants of decisions to travel by alternative modes to private vehicles serves a key purpose with regards to the aim of the research. As stated by Cairns et al. (2008), an appreciation of the psychological antecedents of travel behaviour enables the formulation of behavioural change strategies for encouraging the use of more sustainable modes. Stradling et al. (2000) and Anable (2005) also attest to the fact that behavioural change strategies are more effective when they are targeted at specific groups or market segments.

Accordingly, in the following chapter cluster analysis is used to determine distinct market segments of passengers according to various shared attitudinal and trip characteristics. This relies largely on the extent to which the attitude statements and information in the questionnaire are useful factors for differentiating between the different types of passengers. If this can be achieved, then it should be possible to identify the potential for various groups of passengers to reduce their private vehicle use. This is one of the key strengths of this type of market segmentation as the revealed characteristics of the different groups can not only provide insights into the groups most likely to change their behaviour, but also the types of strategies that might be successful together with the potential opportunities and barriers for achieving this goal.

Chapter 8

Developing segments of passengers with the potential to reduce their private vehicle use

8.1 Introduction

Chapter 8 seeks to "determine segments of passengers with the greatest potential to reduce their private vehicle use (objective 5)." Using carefully selected situational variables (Chapter 6) and attitude statements (Chapter 7), passengers were categorised into distinct market segments using cluster analysis in order to determine *"the potential of different passenger segments to reduce their private vehicle use (research question ix)."*

Analysis is based on 848 respondents from the passenger questionnaire survey, 12 questionnaires had to be discounted due to incomplete responses to attitude statements. Statistical procedures used in the analysis, namely factor analysis and cluster analysis, are described in Section 8.2. Results from this analysis are reported in Section 8.3 together with a discussion of the attitudinal profiles of the various segments and a discussion of their key characteristics. Section 8.4 then identifies segments with the greatest potential to reduce their private vehicle use. Conclusions are then provided at the end of the chapter in Section 8.5.

8.2 Statistical Analysis

Statistical analysis of the data involves two main stages. Firstly, factor analysis was used on responses to attitude statements in the survey. This was undertaken to establish a number of latent psychological factors, and to derive a series of factor scores for use in further analysis. The factor analysis is described in Section 8.2.1. Secondly, the factor scores, along with selected situational variables related to the passenger's trip, were entered into a cluster analysis procedure to derive the different passenger segments. This process is described in Section 8.2.2.

8.2.1 Factor Analysis

Initially, responses to attitude statements from the questionnaire were subjected to exploratory factor analysis in order to identify a number of latent psychological factors, and to derive a series of factor scores for use in further analysis. As discussed in Chapter 5 (Section 5.4.3), factor analysis is a data reduction technique which aims to explain a complex set of variables by reducing them to a smaller number of unobservable (or latent) factors (Dugard et al., 2010).

In the questionnaire a number of statements related only to passengers who claimed to have regular access to a car in the UK. This resulted in a substantial amount of 'missing' data for these statements for passengers who did not have access to a car. Inevitably, passengers without car access have a more limited set of available transport options than passengers with a car. As a result, including both groups in the segmentation procedure may have precluded attitudinal data and other factors from forming meaningful segments and explaining behaviour. To avoid this possibility, passengers with, and without, access to a car were treated separately.

For passengers with car access (*n=664*), 44 attitude statements pertaining to psychological constructs from the Theory of Planned Behaviour, the Norm-Activation Theory and three additional constructs were subjected to principal components analysis with Varimax rotation. As no prior assumptions were made about the structure of the data, the number of factors to be extracted was not pre-determined. The procedure was then repeated for passengers without access to a car (*n=184*). Because a number of statements in the questionnaire only related to passengers with car access, only 33 attitude statements were included in the factor analysis for this group.

A summary of the factor analysis is shown for passengers with car access in Table 8.1. As described in Section 5.4.4, only factors with eigenvalues >1.0 were retained, as shown in the accompanying Scree Plot (Figure 8.1). This yielded a total of ten factors for respondents with car access, representing constructs such as general attitudes towards public transport, awareness of the problem of car access to airports, and perceived social pressure to use public transport.

The rotated component matrix showing factor loadings (λ) is shown in Table 8.2. Attitude statements were considered to load onto a factor if they exhibited a factor loading of ≥.500. The vast majority of items loaded strongly onto one factor ($\lambda \geq .500$, shown in dark font), and weakly onto the other remaining factors ($\lambda < .500$, shown in feint font). The exceptions to this were two items measuring feelings of personal moral obligation to use public transport and feelings of personal moral obligation to use the bus, which loaded onto both the BUS and MORALPT factors, with loadings of $\lambda = .541$, $\lambda = .691$ and $\lambda = .511$, $\lambda = .580$, respectively. This is perhaps understandable, considering that there is a degree of conceptual overlap between these two items. Nine out of the ten factors were found to have an acceptable internal reliability (Cronbach's $\alpha \geq 0.70$), and were subsequently retained for the segmentation procedure.

Table 8.1 Summary of factor analysis for passengers with car access *(n=664)*

Factor	Example attitude statement (item loading highest on factor)	Items loading on factor	Eigen-value	Cronbach's alpha (α)
PTRANS: general attitude towards public transport	How easy would it be for you to use the train to travel to Manchester Airport *(Very Easy-Very Difficult)?*	12	11.602	0.939
AWARE: awareness of, and feelings about, private vehicle access to airports	There is an urgent need to reduce private car use to airports *(Strongly agree-Strongly disagree).*	6	4.003	0.838
TAXI: attitudes towards taxis	How likely is it that you will use a taxi to get to Manchester Airport *(Very likely-Very unlikely)*?	5	3.004	0.831
BUS: attitudes towards bus	How likely is it that you will use a bus to get to Manchester Airport *(Very likely-Very unlikely)*?	5	2.655	0.854
MORALPT: Moral obligations to use public transport	Regardless of what other people do, I feel morally obliged to use public transport instead of my car to get to the airport *(Strongly agree-Strongly disagree).*	4	2.159	0.902
CAR: attitudes towards car	How likely is it that you will use a car to get to Manchester Airport *(Very likely-Very unlikely)*?	3	1.859	0.785
DROPOFF: attitudes towards drop-off	How easy would it be for you to be dropped-off when you travel to Manchester Airport *(Very Easy-Very Difficult)?*	3	1.583	0.794
MORALCAR: moral obligations to use a car/drop-off	When travelling to Manchester Airport, I would feel a strong moral obligation to be dropped-off *(Strongly agree-Strongly disagree).*	3	1.298	0.778
SOCIAL: perceived social pressure to use a car	Would people who are important to you approve or disapprove of you using a car to get to Manchester Airport *(Strongly approve-Strongly Disapprove)?*	2	1.164	0.809

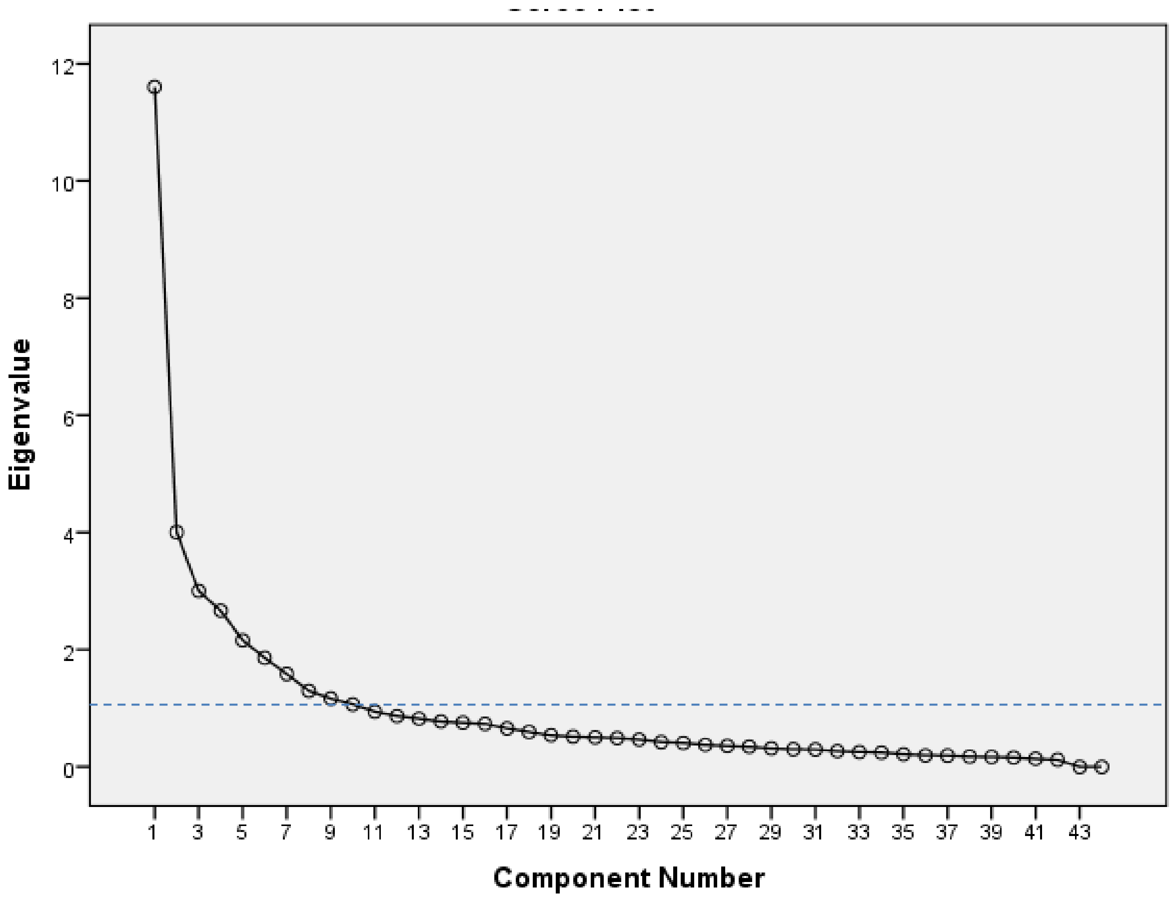


Figure 8.1 Scree plot for passengers with car access *(n=664)*

Table 8.2 Rotated component matrix for passengers with car access *(n=664)*

Item	Factor								
	PTRANS	AWARE	TAXI	BUS	MORALPT	CAR	DROPOFF	MORALCAR	SOCIAL
General problem awareness car use 1	.186	.717	.057	.044	.004	-.052	-.023	.033	-.022
General problem awareness car use 2	.146	.753	.000	.069	.050	-.080	-.084	-.005	-.084
Efficacy	.059	.152	-.137	.072	.147	-.168	.030	-.014	-.053
Descriptive norm	-.156	-.019	-.314	.027	-.169	.419	.052	.153	-.165
Awareness of negative effects of car 1	.122	.587	.005	-.028	.012	.135	-.108	-.019	.097
Anticipated feelings of guilt 1	.218	.698	-.003	.128	.230	-.172	.026	-.038	.026
Awareness of negative effects of car 2	.067	.741	-.004	.046	.112	-.076	-.042	-.027	.053
Anticipated feelings of guilt 2	.209	.713	-.043	.103	.189	-.140	.074	.003	.026
Personal norm PT1	.121	.236	.037	.541	.691	.015	-.027	.023	-.173
Personal norm PT2	.431	.246	-.064	.007	.732	-.059	-.069	.220	.068
Attitude to public transport 1	.637	.306	.017	.118	.073	-.053	-.067	-.004	-.102
Subjective norm public transport 1	.530	.425	.063	.125	.026	-.017	-.062	.083	-.214
PBC public transport 1	.811	.106	.055	.239	.039	-.143	.024	-.058	.025
Attitude to PT2	.628	.135	-.011	.093	.050	-.074	-.078	.035	-.100
Intention to public transport 1	.788	.212	-.054	.203	.002	-.213	-.086	.026	-.069
PBC public transport 2	.795	.027	.026	.215	.095	-.056	.011	-.112	.056
Attitude to public transport 3	.704	.175	-.045	.212	-.019	-.035	-.002	.082	-.147
Intention to public transport 2	.788	.188	-.078	.180	.024	-.218	-.075	.082	-.075
Subjective norm public transport 2	.591	.322	-.007	.175	-.059	-.049	-.052	.159	-.219

Table 8.2

continued

PBC Bus	.331	.041	.114	.727	.034	-.083	-.011	-.065	.086
PBC Train	.814	.012	-.030	.018	.198	-.071	-.062	-.127	.067
PBC Car	-.114	-.012	.051	-.109	.079	.756	.250	.012	.080
PBC Dropped-off	-.047	-.038	.193	-.068	.063	.137	.831	.012	.060
PBC Taxi	-.040	-.005	.793	.037	.028	.043	.237	.004	-.077
Attitude Car	-.187	-.195	-.027	-.009	-.051	.748	.162	.072	.099
Attitude Dropped-off	-.139	-.095	.156	-.061	-.098	.198	.691	.050	.122
Attitude Taxi	-.110	-.018	.822	.046	-.043	.034	.170	.045	-.048
Attitude Bus	.258	.111	.043	.744	.122	-.042	-.085	-.028	.035
Attitude Train	.757	.124	-.127	.022	.261	-.043	-.139	-.086	.081
Subjective norm Train	.499	.108	.044	-.061	.173	.014	-.134	-.110	.153
Subjective norm Taxi	-.008	.028	.725	.026	-.052	-.071	-.051	.108	.271
Subjective norm Car	-.070	.025	-.029	.063	-.034	.302	.082	.176	.797
Subjective norm Dropped-off	-.069	.081	.052	.076	-.044	-.027	.387	.206	.778
Subjective norm Bus	.157	.017	.135	.387	.069	.066	-.094	-.205	-.268
Personal norm Bus	.141	.336	.027	.531	.580	.017	-.048	.043	-.162
Personal norm Car	-.077	-.083	-.020	-.055	.069	.166	-.007	.821	.157
Personal norm Dropped-off	-.044	-.009	.057	-.079	.124	.025	.127	.852	.155
Personal norm Train	.431	.246	-.064	.007	.732	-.059	-.069	.220	.068
Personal norm Taxi	.019	.105	.542	.042	.151	-.067	-.034	.620	-.006
Intention Car	-.247	-.100	-.053	-.117	-.021	.772	.075	.069	.123
Intention Dropped-off	-.171	-.077	.101	-.054	-.088	.161	.788	.116	.143
Intention Train	.792	.073	-.120	-.059	.225	-.107	-.111	-.109	.116
Intention Taxi	-.075	.001	.828	.053	-.046	-.089	.104	-.014	-.067
Intention Bus	.262	.093	.002	.754	.080	-.128	-.074	-.014	.078

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

A summary of the factor analysis is shown for passengers without car access in Table 8.3. Eight factors with an eigenvalue of >1.0 were generated in total (see Figure 8.2). These were largely similar to those for passengers with car access, with the exception of Factor 6 (MORALAWAY: moral obligations to use drive away modes), and Factor 7 (SOCIALPT: perceived social pressure to use public transport). The rotated component matrix for passengers without car access is shown in Table 8.4. All items loaded heavily on one factor ($\lambda \geq .500$, shown in dark font) and weakly on the remaining factors ($\lambda < .500$, shown in weak font). Seven out of the eight factors had an acceptable internal reliability (Cronbach's $\alpha \geq 0.70$), and were retained for further analysis.

Factor scores for both the car access and non-car access group were calculated for use in the segmentation procedure. These represent a rating for each passenger on each of the different factors, based on the attitude scores for the items that formed them. In both groups it was common for factors to reflect individual modes rather than psychological constructs. For example, statements referring to taxi use would load on one factor while those for drop-off would load on another. This was probably because passengers tended to rate constructs pertaining to the same mode in a similar way without actually considering their attitudes. Incorporating attitude statements about feelings towards travel in general, and increasing the number of items measuring each psychological construct would perhaps help resolve this, although this was not possible for the current research because of time and space constraints.

Table 8.3 Summary of factor analysis for passengers without car access (*n=184*)

Factor	Example attitude statement (item loading highest on factor)	Items loading on factor	Eigen value	Cronbach's alpha (α)
PTRANS: general attitude towards public transport	For me, using public transport to get to Manchester Airport would be easy *(Strongly agree-Strongly disagree).*	12	12.677	0.927
BUS: attitudes towards bus	How likely is it that you will use a bus to get to Manchester Airport *(Very likely-Very unlikely)*?	4	3.094	0.855
TAXI: attitudes towards taxis	Would people who are important to you approve or disapprove of you using a taxi to get to Manchester Airport *(Strongly approve-Strongly Disapprove)?*	4	2.025	0.830
DROPOFF: attitudes towards drop-off	How likely is it that you will be dropped-off when you travel to Manchester Airport *(Very likely-Very unlikely)*?	4	1.783	0.802
AWARE: awareness of, and feelings about, private vehicle access to airports	Private car access to airports is a major environmental problem *(Strongly agree-Strongly disagree).*	4	1.422	0.733
MORALAWAY: moral obligations to use drive away modes	When travelling to Manchester Airport, I would feel a strong moral obligation to be dropped-off *(Strongly agree-Strongly disagree).*	2	1.287	0.771
SOCIALPT: perceived social pressure to use public transport	Would people who are important to you approve or disapprove of you using the bus to get to Manchester Airport *(Strongly approve-Strongly Disapprove)?*	2	1.178	0.722

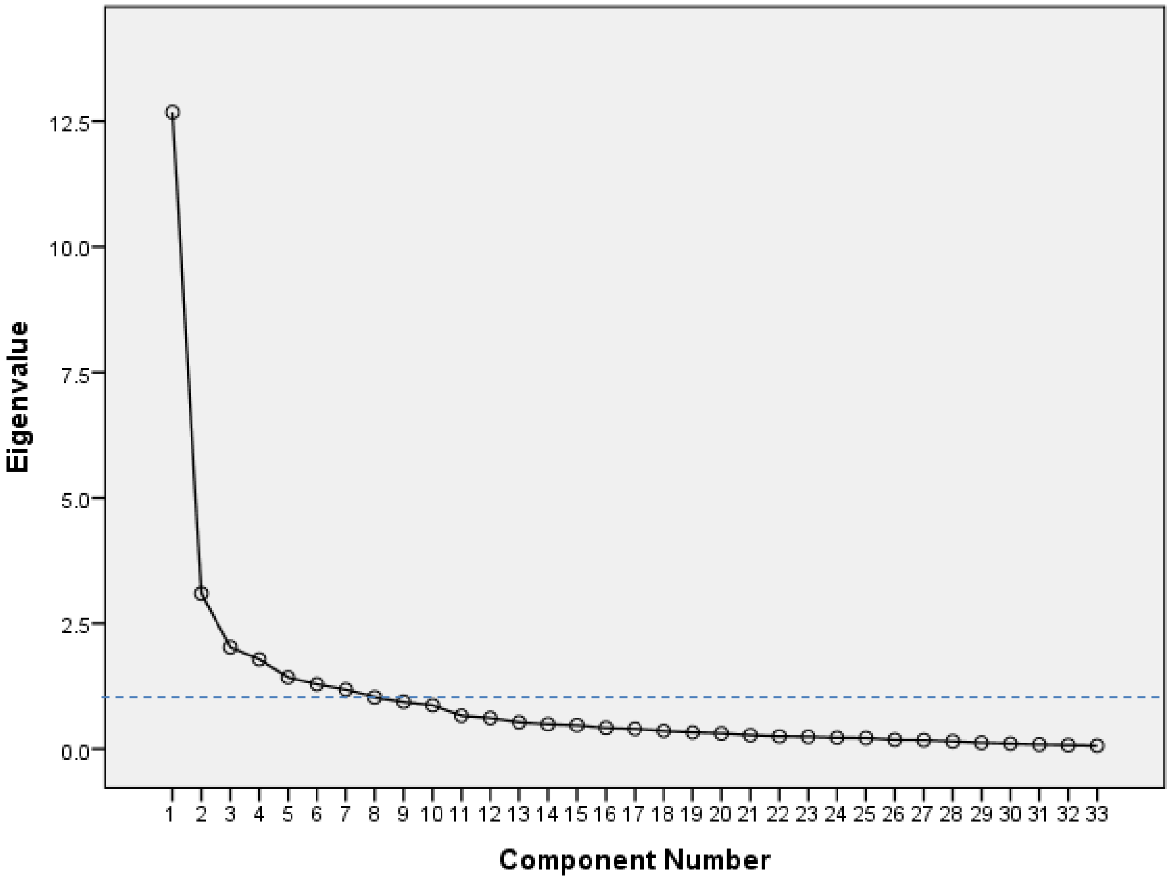


Figure 8.2 Scree Plot for passengers without car access *(n=184)*

Table 8.4 Rotated Component Matrix for passengers without car access (*n=184)*

Item	Factor						
	PTRANS	BUS	TAXI	DROPOFF	AWARE	MORALAWAY	SOCIALPT
General problem awareness car use 1	.219	-.037	-.100	.126	.807	-.055	.105
General problem awareness car use 2	.229	.042	-.066	.053	.736	-.134	.194
Descriptive norm	-.096	-.096	.157	.012	.035	-.036	-.156
Efficacy	.119	.243	-.097	-.357	.152	.010	.041
Attitude to public transport 1	.730	.197	-.101	-.172	.201	-.010	.187
Subjective norm public transport 1	.700	.116	-.050	-.169	.216	.072	.410
PBC public transport 1	.854	.214	-.182	-.113	.050	-.096	.051
Attitude to PT2	.809	.176	-.021	-.143	.098	-.102	-.031
Intention to public transport 1	.831	.214	-.149	-.241	.043	-.095	.073
PBC public transport 2	.831	.156	-.170	-.077	.037	-.159	.027
Attitude to public transport 3	.802	.105	-.083	-.068	.101	.032	.002
Intention to public transport 2	.839	.213	-.147	-.269	.110	-.061	.094
Subjective norm public transport 2	.683	.170	-.060	-.158	.174	.007	.412
PBC Bus	.382	.785	.006	.015	-.078	-.053	.054
PBC Train	.828	.110	-.225	-.129	.119	-.023	.111
PBC Dropped-off	-.367	.030	.140	.684	.094	.217	-.016
PBC Taxi	-.171	-.025	.744	.193	-.142	.142	.037
Attitude Dropped-off	-.331	.017	.200	.665	-.020	.044	-.043
Attitude Taxi	-.271	-.100	.763	.131	-.144	.084	.084
Attitude Bus	.322	.805	-.034	.013	.050	-.035	.220
Attitude Train	.787	.129	-.210	-.194	.196	-.017	.152
Subjective norm Train	.405	.105	-.139	-.158	.186	.104	.701
Subjective norm Taxi	-.088	.021	.778	.156	.025	-.003	-.122
Subjective norm Dropped-off	-.064	.031	.276	.626	.160	.088	-.153
Subjective norm Bus	.194	.408	.080	-.056	.097	-.159	.705
Personal norm Bus	.078	.619	-.047	-.196	.402	.181	-.144
Personal norm Dropped-off	-.056	-.040	.038	.368	-.027	.822	-.054
Personal norm Train	.306	.218	-.169	-.240	.600	.333	-.040
Personal norm Taxi	-.155	.003	.411	.025	-.026	.779	.030
Intention Dropped-off	-.362	-.061	.001	.760	-.017	.139	-.079
Intention Train	.825	.080	-.227	-.187	.167	.059	.144
Intention Taxi	-.346	.016	.730	.029	-.074	.156	-.078
Intention Bus	.257	.847	-.021	-.014	.034	-.010	.190

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

8.2.2 Cluster Analysis

The various factors were then subjected to cluster analysis. As discussed in Chapter 5 (Section 5.4.4), cluster analysis is an exploratory statistical technique that aims to develop meaningful subgroups (or clusters) of individuals or objects based on their similarities (or differences) on selected characteristics. It does this by attempting to maximise homogeneity within the clusters, and heterogeneity between the clusters (Hair et al., 2005).

In addition to the factors outlined in Tables 8.1 and 8.3, five additional variables relating to situational variables were included in the cluster analysis. These variables were found to significantly affect mode choice in the multinomial logistic regression procedure outlined in Chapter 6 (Section 6.7), and were therefore considered to be useful additional variables on which to base the clusters. A measure of overall mode choice *(car, drop-off, taxi, or public transport)* was also entered into the cluster analysis procedure to this end.

The six additional variables in the cluster analysis were:

- Mode choice *(Car/Drop-off/Taxi/Public Transport)*

- Trip purpose *(Business/Leisure)*

- Carrying checked luggage *(Yes/No)*

- Travel Group Size *(Alone/Group)*

- Time of access *(Early/Not early)*

- Journey distance *(<60 mins/≥60 mins)*

As is common practice in cluster analysis, a two stage approach was adopted. Initially, a hierarchical (agglomerative) procedure (Ward's Method) was applied to investigate the structure of the data and to establish the possible number of clusters. Parameters were set so that a four, five and six cluster solution was produced for passengers with access to a car, and a two, three and four cluster solution was produced for passengers without access to a car. Further, it was defined that an individual cluster should contain no fewer than 50 cases for the car access group, and no fewer than 25 cases for the non-car access group. This ensured that each cluster was populated sufficiently and to minimise the potential impact of outliers in the data.

Various stopping rules identified from the literature (Hair et al., 2005; Dugard et al., 2010; Everitt et al., 2011) were used to determine the most appropriate number of clusters. Subsequently, six distinct clusters were identified for passengers with car access, while passengers without car access were split into two clusters. This is shown in Figures 8.3 and 8.4, which show the dendrograms produced as part of the clustering procedure. The dotted line represents the point at which the dendrogram is 'cut', and the optimum number of clusters is selected (which in this case is 6 clusters and 2 clusters, respectively). Essentially, this process seeks to identify the point at which heterogeneity *between* clusters is at its maximum, but heterogeneity *within* each cluster is at its minimum. The agglomeration schedules for the cluster analyses are shown in Appendix D. These display the cases or clusters combined at each stage, the distances between the cases or clusters being combined, and the last cluster level at which a case joined the cluster.

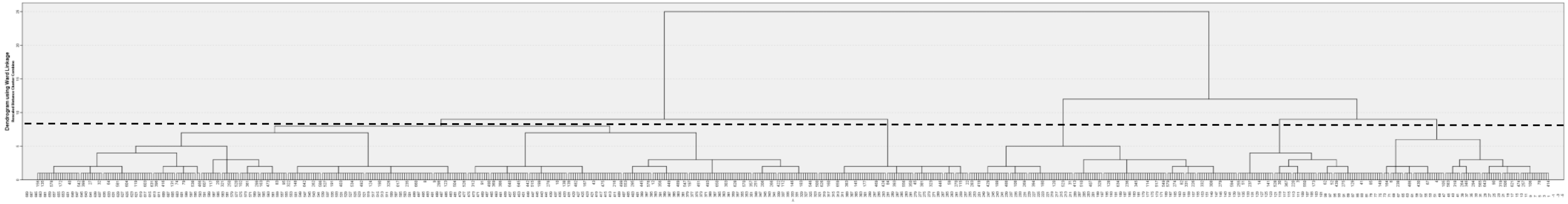


Figure 8.3 Dendrogram for passengers with car access (*n=664)* showing ‘cut’ point (dotted line)

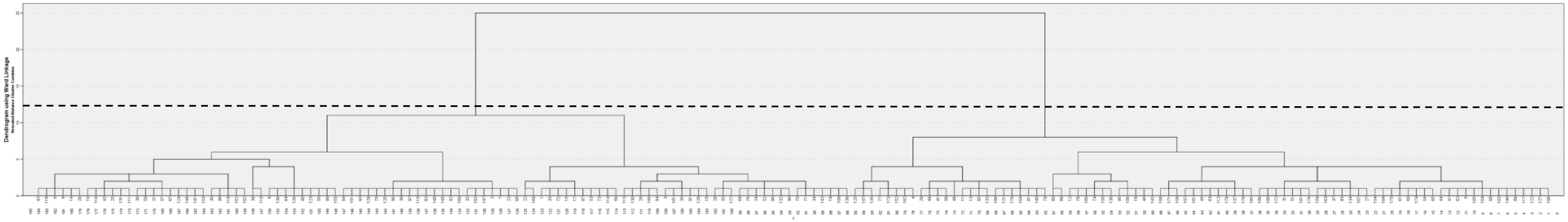


Figure 8.4 Dendrogram for passengers without car access (*n=184)* showing ‘cut’ point (dotted line)

Having established the required number of clusters the procedure was re-run using a more robust non-hierarchical (divisive) clustering technique (K-Means). Once the clustering solution had been finalised, each cluster was profiled in terms of their shared attitudinal and trip characteristics. This is described in the following section.

8.3 Passenger market segments

The cluster analysis yielded eight distinct groups (or segments) in total; six for passengers with access to a car and two for passengers without car access. In this section each of these segments is profiled in terms of their shared attitudinal profile (8.3.1), situational characteristics (8.3.2) and personal factors (8.3.3).

8.3.1 Attitudinal profile

Initially, mean factor scores were calculated for each group and were used to assign an overall name for each cluster summarising its general attitudinal outlook. The eight segments are detailed in Table 8.5.

Table 8.5 Summary of passenger segments

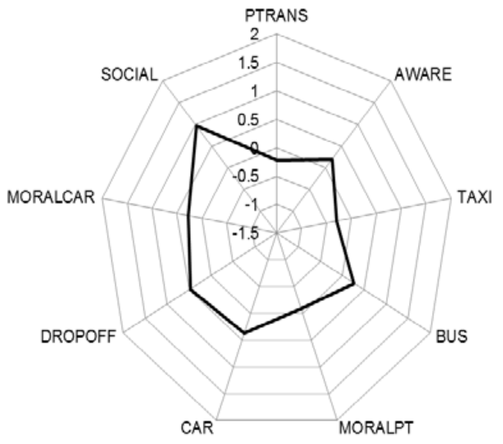
Segment	Car access	Share (%)
1. Complacent motorists	Yes	16.9%
2. Dogmatic Drop-offs	Yes	15.6%
3. Ardent Taxi users	Yes	13.8%
4. Devoted Drivers	Yes	16.9%
5. Conflicted Greens	Yes	9.2%
6. Environmental Champions	Yes	5.9%
7. Pessimistic lift seekers	No	11.3%
8. Public Transport Advocates	No	10.4%

The mean factor scores were then plotted onto star charts to show how the attitudinal outlook of each group varied. The star charts, along with the name and relative size of each cluster, are shown in Figure 8.5. Clusters 1-6 refer to the car access clusters, while clusters 7 and 8 relate to passengers without car access.

As can be seen, there is significant variation in the attitudinal profile of the different clusters. The joint largest cluster, the *Complacent Motorists,* is characterised predominantly by the perceived social pressure they feel to use their car or be dropped-off. This contrasts notably with the other car access clusters, where mean factor scores for perceived social pressure are generally much lower. In addition, the *Complacent Motorists* are strongly defined by their favourable attitudes towards car and drop-off. Despite this, they are relatively aware of the problems associated with private vehicle access to airports, and recognise the negative impact their own car use has.

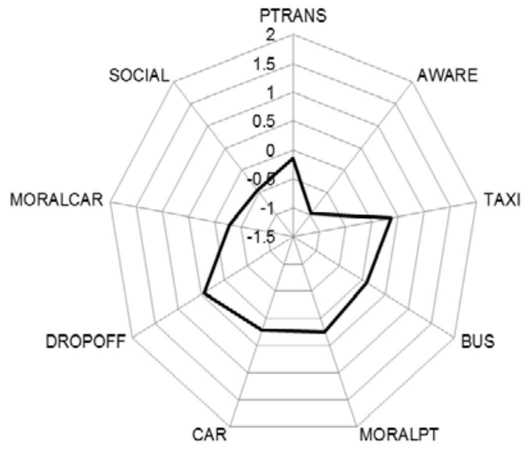
Figure 8.5 Star charts showing mean factor scores and attitudinal profile for each cluster

1. Complacent Motorists (16.9%)



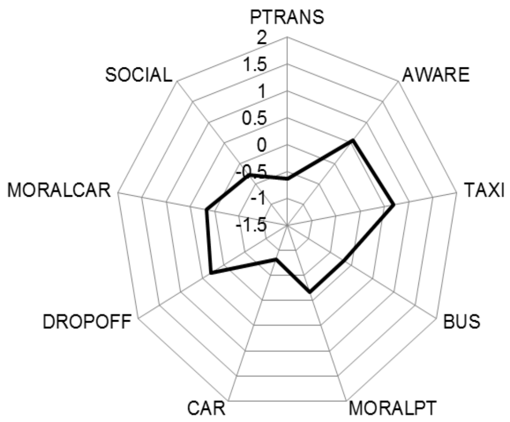
Feel social pressure to use their car. Hold a positive attitude towards car and drop-off. Are aware of the problem of car access to airports and the negative impacts of their own car use, but feel that they can do little to improve the situation.

2. Dogmatic Drop-offs (15.6%)



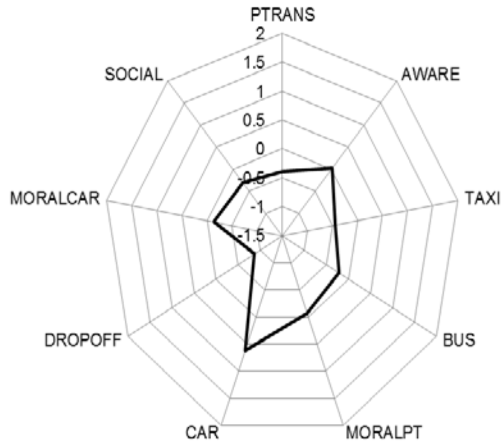
Do not feel that car access to airports is a problem, do not feel pressure to use public transport and would not feel guilty about continuing to use their private car. They hold a negative attitude towards public transport in general.

3. Ardent Taxi Users (13.8%)

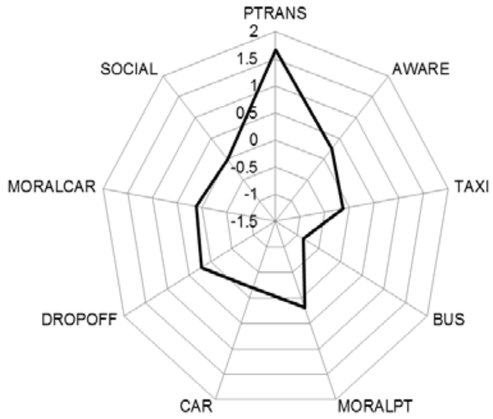


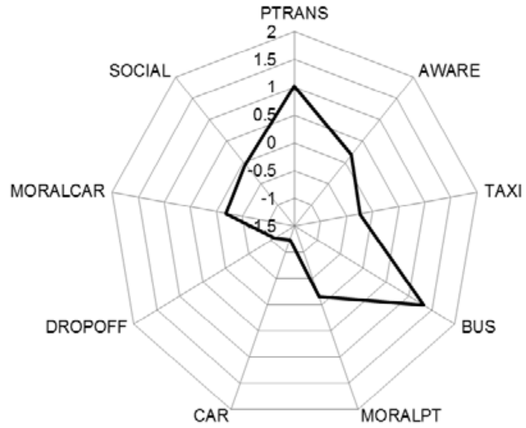
Consider car access to airports to be a problem. They have strong positive attitudes towards taxis, perceive few barriers to using them and intend to use them again in the future. In contrast, they have relatively negative views of public transport.

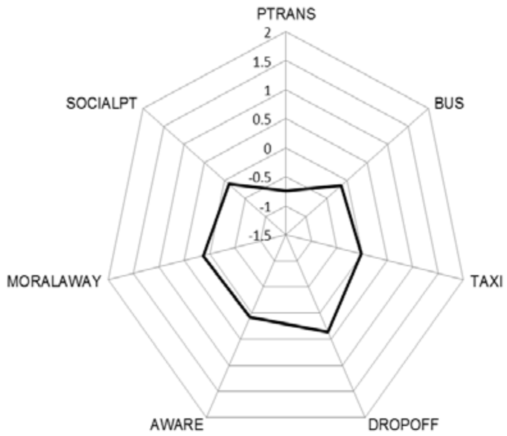
4. Devoted Drivers (16.9%)

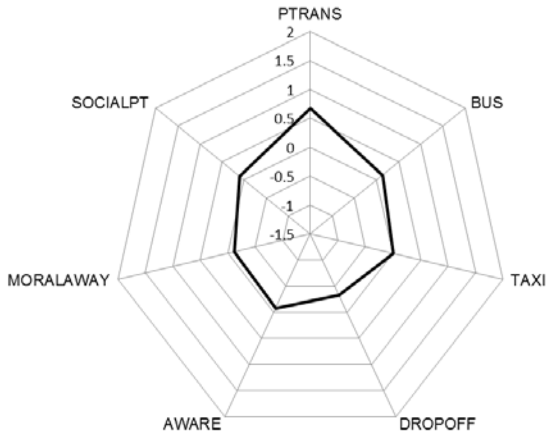


This group hold very positive attitudes towards car use. They perceive significant barriers to using public transport and have little intention of using it for future trips. They generally hold negative attitudes towards using taxis.

5. Conflicted Greens (9.2%)	
	Hold positive attitudes towards using public transport and have a strong intention to use it in the future. They generally think that public transport is easy to use, yet hold a more positive attitude towards using the car, drop-off and taxi than the bus.

6. Environmental Champions (5.9%)	
	Hold very positive attitudes towards the bus and public transport in general, but do not feel a moral obligation to use public transport. Generally very negative views of car and drop-off.

7. Pessimistic Lift Seekers (11.3%)	
	This group do not have access to a car in the UK. They hold positive attitudes to using drop-off, and to a lesser extent, taxis. They consider public transport to be difficult to use, view it in a negative light and have a low intention to use it for future surface access journeys.

8. Public Transport Advocates (10.4%)	
	This group also do not have access to a car, yet they consider public transport easy to use, and generally have a positive view of it. They feel a degree of social pressure to use public transport. They are fairly indifferent to other modes.

The *Dogmatic Drop-offs* generally hold a very different view from this. They disagree strongly with the idea that private car access to airports is a problem, and claim that they would feel little guilt about continuing to use their car for surface access journeys in the future. General attitudes towards public transport for this group are largely negative, whereas drop-off and taxi use are both viewed more favourably. Feelings of personal moral obligation to use public transport are stronger than perhaps might have been expected considering the overall stance of the group.

The *Ardent Taxi Users* exhibit the strongest awareness of the problems associated with private vehicle access to airports. This does not appear, however, to have translated itself into increased feelings of personal moral obligation to use public transport. Attitudes towards public transport are generally negative, whereas feelings towards taxi use are much more favourable, as implied by the group's name.

In a similar fashion, the *Devoted Drivers* are defined primarily by their positive opinions of car use. Interestingly, unlike the other car access groups, the *Devoted Drivers* perceive all other modes negatively in comparison with the car, even taxi and drop-off modes. For this cluster it would seem that few, if any, other modes are considered apart from the car for their journey to the airport.

While attitudinal segmentation typically generates clusters with attitudes that are consistent with each another, on occasion it can also yield what appear to be conflicting opinions within a group. This is the case for the *Conflicted Greens,* who, despite having the most positive attitude towards public transport in the sample and feeling under the most social pressure to use it, are shown to have a more positive attitude towards car, drop-off and taxi than the bus. Looking at the results of the factor analysis (Table 8.1), items relating to train use loaded highly on the first factor

PTRANS (general attitude towards public transport). As such, it is likely that the *Conflicted Greens* view of public transport overall is largely the result of their attitude towards the train.

The last car access cluster, the *Environmental Champions,* are defined by their very positive attitudes to using the bus and their positive opinions of using public transport, coupled with a very negative view of using drop-off and the car. From the mean factor scores, it would seem that their favourable attitude towards the bus and public transport are born from an inherent preference for these modes, rather than a moral obligation to use them.

Considering the clusters without car access, the two factors that differentiate the *Pessimistic Lift Seekers* from the *Public Transport Advocates* are general attitudes towards public transport and attitudes to being dropped-off. The *Pessimistic Lift Seekers* hold a positive view of being dropped-off, and to a lesser extent, using a taxi, but have a much more negative attitude towards using public transport than the *Public Transport Advocates*. The latter also feel a stronger social pressure to use public transport than the *Pessimistic Lift Seekers.*

8.3.2 Situational characteristics

Table 8.6 profiles each segment in terms of its trip related characteristics. The table includes the six additional situational variables included in the cluster analysis as described in Section 8.2.2.

Findings indicate that a passenger's mode choice is largely consistent with their attitudinal outlook. The *Complacent Motorists* cluster is fairly evenly divided between passengers who were dropped-off (53.5%) and those who travelled by car (45.8%).

Table 8.6 Trip related variables for each cluster

		1.Complacent Motorists (%)	2.Dogmatic Drop-offs (%)	3.Ardent Taxi users (%)	4.Devoted Drivers (%)	5.Conflicted Greens (%)	6.Environmental Champions (%)	7.Pessimistic Lift Seekers (%)	8.Public Transport Advocates (%)
Mode	*Car*	45.8	16.7	0.9	94.4	0	0	19.3*	0*
	Drop-off	53.5	50.8	29.9	5.6	21.8	0	58.0	0
	Taxi	0.7	30.3	67.5	0	21.8	20.0	22.7	18.8
	Public Transport	0	2.2	1.7	0	56.4	80.0	0	81.2
Trip purpose	*Business*	14.6	30.3	26.5	24.5	17.9	20.0	25.0	25.0
	Leisure	85.4	69.7	73.5	75.5	82.1	80.0	75.0	75.0
Bag	*Yes*	86.8	79.5	87.2	83.2	78.2	86.0	77.3	77.1
Flight Time	*Early/Late*	13.2	28.8	19.7	25.9	10.3	20.0	6.8	9.4
Group	*Alone*	43.1	46.2	45.3	31.5	44.9	58.0	53.4	79.2
Journey Distance	<60 mins	68.8	84.1	84.6	47.6	50.0	58.0	63.6	49.0
	≥60 mins	31.2	15.9	15.4	52.4	50.0	42.0	36.4	51.0

Note: * denotes rental car

Drop-off journeys represent the largest share of trips for the *Dogmatic Drop-offs* (50.8%), followed by taxi (30.3%), and car (16.7%). The *Ardent Taxi* users, as their name suggests, are strongly associated with taxi use (67.5%), with drop-off accounting for the remaining journeys in this group (29.9%). The *Devoted Drivers* cluster is almost entirely dominated by car trips (94.4%), and is the only group where car journeys represent the majority mode. Public transport represents the primary mode choice for both the *Conflicted Greens* (56.4%) and the *Environmental Champions* (80.0%), which are the two smallest clusters in terms of group membership.

Available transport options are inevitably limited for the two clusters without car access. The majority of trips by the *Pessimistic Lift Seekers* are shown to be drop-off trips (58.0%). The 19.3% of 'car' trips by this group were by rental car. The *Public Transport Advocates* cluster, on the other hand, is strongly associated with trips by public transport (81.2%).

In terms of trip purpose, business passengers are proportionally underrepresented in the *Complacent Motorists, Conflicted Greens* and *Environmental Champions* clusters, whereas they form a relatively larger share of the *Dogmatic Drop-offs* group.

The significant majority of passengers in the sample were travelling with a piece of checked-in luggage. It can be seen that the two groups with the highest share of passengers carrying a checked-bag (*Ardent Taxi Users,* 87.2% and *Complacent Motorists,* 86.8%) are both groups dominated by private vehicle modes. The *Environmental Champions* also have a high share of passengers carrying a checked-bag (86.0%), despite 80% of this group travelling by public transport. This would seem to suggest that, for these passengers at least, carrying luggage does not provide a barrier to using public transport.

The *Dogmatic Drop-Offs* (28.8%) and the *Devoted Drivers* (25.9%) have the largest share of passengers travelling to the airport early in the morning (23:00-09:00). In contrast, only a relatively small percentage of passengers in the two non-car access clusters were travelling at these times, albeit with fewer total passengers. The reasons for this are hard to pinpoint, although it is possible that passengers without access to a car deliberately avoid travelling early in the morning precisely because they cannot call upon their own car.

Travel group size was shown to have an important role in public transport use in the analysis in Chapter 6 (Section 6.7). Subsequently, the groups with the highest share of passengers travelling alone, the *Public Transport Advocates* (79.2%) and the *Environmental Champions* (58.0%), are those with the highest share of trips by public transport. In contrast, the *Devoted Drivers* have the lowest share of passengers travelling alone (31.5%). This is interesting from an environmental and congestion perspective as it shows that the majority of passengers travelling by car are travelling in groups rather than on their own.

Journey distance was shown to be particularly important in decisions to travel by drop-off and taxi (Section 6.7). This finding is supported in the cluster analysis, as the two groups characterised by high taxi and drop-off use (the *Ardent Taxi Users* and the *Dogmatic Drop-offs)* are both characterised by passengers who started their journey in areas closer to the airport. In contrast, the majority of passengers in the *Devoted Drivers* and *Public Transport Advocates* clusters started their journey in areas further away from the airport.

8.3.3 Personal characteristics

Personal characteristics were not included as factors in the clustering procedure but are shown in Table 8.7 to indicate the variations in age, gender and country of residence for each group. Passengers aged under 35 years of age are overrepresented in the *Complacent Motorists* (45.8%)*, Conflicted Greens* (41.0%)*,* and *Public Transport Advocates* (40.2%) compared with the sample overall. In contrast, the *Devoted Drivers* (17.5%) have by far the lowest share of younger passengers. The *Environmental Champions* (24.0%) and *Ardent Taxi Users* (26.5%) also have relatively fewer passengers under the age of 35.

Table 8.7 Personal characteristics for each cluster

Cluster	**Age (<35 years) (%)**	**Gender (Female) (%)**	**Residence (UK) (%)**
1. Complacent Motorists	45.8	60.4	91.0
2. Dogmatic Drop-Offs	34.8	47.0	93.2
3. Ardent Taxi Users	26.5	47.0	95.7
4. Devoted Drivers	17.5	38.5	94.4
5. Conflicted Greens	41.0	52.6	92.3
6. Environmental Champions	24.0	60.0	96.0
7. Pessimistic Lift Seekers	29.5	60.2	31.8
8. Public Transport Advocates	40.2	39.6	40.6
Sample average (n=860)	*33.5*	*49.7*	*81.3*

Female passengers represented just under half of respondents in the survey (49.7%). The results of the cluster analysis show that female passengers are overrepresented in the *Complacent Motorists* (60.4%), *Pessimistic Lift Seekers*

(60.2%), and the *Environmental Champions* (60.0%) segments. The *Devoted Drivers* (38.5%) and the *Public Transport Advocates* (39.6%), on the other hand, have relatively fewer female passengers. As expected, the vast majority of passengers in the car access clusters lived in the UK, whereas the passengers without car access were more likely to reside abroad.

8.4 Assessing the potential for reducing private vehicle use

The purpose of defining a number of distinct market segments of passengers in the previous section was to determine *"the potential of different passenger segments to reduce their private vehicle use (research question ix)."* One of the main strengths of *post hoc* segmentation based on shared attitudinal information, as opposed to simple observable characteristics, is that it can be used to highlight possible barriers and/or opportunities for affecting behavioural change in the future, rather than merely providing a brief 'snapshot' of the current situation. This can then help to guide future decision making in terms of the sorts of policies and practical strategies that could be successful in engendering change.

Table 8.8 provides a classification of the 8 passenger segments in terms of the potential opportunities, barriers, and strategic options for reducing their private vehicle use. Ratings are also provided for each group regarding their potential for reducing private vehicle use, as well as a suggestions about the possible 'next best' mode options for each group. This relates to the 'Hierarchy of Preferred Transport Choices' detailed in Manchester Airports ASAS, and discussed in Section 5.3.1. In essence, it identifies which (if any) modes of transport would be realistic ambitions in terms of achieving modal shift for each group based on their attitudinal and revealed characteristics.

As Table 8.8 illustrates, the potential for achieving reductions in private vehicle use between the different segments varies. The *Ardent Taxi Users* and the *Devoted Drivers* are shown to be the most resistant to change, due largely to their strong favourable opinions of taxis and car use, respectively, combined with their negative opinions of public transport. While attitudes may change over time, this would appear to be an unlikely prospect for these two groups. In all likelihood these passengers will continue to behave in a manner consistent with their prevailing outlook. Rather than trying to change the behaviour of these passengers, a practice that would arguably be futile, it would make more sense from an airport management perspective to focus efforts on maintaining current patterns of behaviour and limiting 'negative' behavioural change towards passengers switching towards drop-off.

A similar approach may also be needed for the *Dogmatic Drop-offs,* who also show a low potential for reducing their private vehicle use. While other segments (even those with high private vehicle use) displayed an awareness of the issues of car access to airports to some degree, the *Dogmatic Drop-Offs* barely perceive there to be a problem at all. Given that reducing the share of drop-off/pick-up journeys was highlighted as a key priority by airport managers in the scoping study (Section 3.3.1), it is concerning that these passengers are shown to be among the most resistant to change. While trying to educate these passengers with regards to the surface access problem may have some impact, in reality if airport managers are to reduce the share of drop-off trips then harder market-based measures would probably need to be considered carefully.

Table 8.8 Opportunities, barriers and strategic options for reducing private vehicle use for different passenger segments

	Current mode	Attitudinal profile	Opportunities	Barriers	Potential to reduce private vehicle use	Strategic options	Next best mode
Complacent Motorists (16.9%)	Drop-off Car	Feel social pressure to use the car Aware of the problem of car access, but feel they can do little to help	Possibly susceptible to perceived social pressures to act in a certain way	Negative attitudes towards public transport Weak perceived efficacy of their own actions	Low	Conveying the importance of individual decisions in achieving shared goals. Consider the role of perceived social pressures to reduce private vehicle use	Car Parking
Dogmatic Drop-offs (15.6%)	Drop-off	Do not feel that there is a problem Will not feel guilty about using private vehicles in the future Positive attitude towards drop-off	Few	Do not think what they are doing is a problem Negative attitudes towards public transport	Low	Education about the problems caused by car access, and the impacts this could have on them personally. Market based disincentives	Car Parking Taxi
Ardent taxi users (13.8%)	Taxi	Strong positive attitudes to taxis and feel that they are easy to use Aware of the problem of car access Negative view of car and public transport	They are aware of the problems associated with car access to airports Perceived behavioural control (i.e. ease) important for this group	Positive attitude to taxis Negative view of the car, but a more positive attitude to drop-off	Very low	Promote positive aspects of public transport and car parking, and the negative impacts of drop-off	None, but not drop-off
Devoted Drivers (16.9%)	Car	Very positive attitudes towards car, very negative attitudes towards all other modes	Very few, although they do have a strong negative view of drop-off	Very low intention to use public transport Consider public transport difficult to use	Very low	Reduce availability of car parking	None

Table 8.8 continued

Conflicted Greens (9.2%)	Public Transport Drop-off Taxi	Positive attitudes towards public transport, think that it is easy to use and have strong intention to use it in the future But more positive views of drop-off and taxi than the bus	Existing positive views of public transport	Negative views of bus Moderately positive view of drop-off and taxi Feel some social pressure to use the car	Moderate-High	Improve perceptions of bus Reinforce positive aspects of travelling by public transport and continue to provide incentives (for example, loyalty schemes)	Public transport
Environmental Champions (5.9%)	Public Transport	Very positive attitudes towards using the bus and public transport in general, but does not appear to be morally guided High perceived behavioural control Very negative opinions of all other modes	Consider that public transport is easy to use and have strong intentions to use it for future journeys	Few	Very high	Continue to promote alternative to private vehicle modes and maintain service levels for trains and buses	Public Transport, especially bus/coach
Pessimistic Lift Seekers (11.3%)	Drop-off	Consider public transport to be difficult to use (low perceived behavioural control), and have a low intention to use it in the future Strong intention to use drop-off in the future	Lack of car access	Preference for private vehicle modes Perceive public transport to be difficult to use, and have a negative view of using it	Moderate	Promote the ease with which public transport and alternative modes can be used Provide more information relating to alternative modes as these passengers are non-UK residents	Public transport Rental car
Public Transport Advocates (10.4%)	Public Transport	Fairly positive attitude towards public transport, feel it is easy to use display a degree of social pressure to use it. Moderate view of other modes	Lack of car access Current attitudes	Few	Very High	Reinforce benefits of public transport	Public transport

The *Complacent Motorists* pose a slightly different set of problems. While they appear more aware of the problems associated with car access to airports, they may be reluctant to use modes other than private vehicles because they think that their own actions will have little impact. As a result, emphasising the importance of individual travel decisions may represent a possible strategy for achieving behavioural change in this group. Further insight may also be gained from the perceived social pressure they feel to use their car. If these passengers are more susceptible to perceived social pressures in general, it makes sense from a strategic perspective to try and invert this process and emphasise the social expectations around using public transport alternatives.

At the other end of the spectrum are the *Environmental Champions* and the *Public Transport Advocates,* whose attitudinal profiles reveal positive attitudes towards using public transport and negative or less favourable attitudes towards other modes. While it is important this behaviour is maintained, from a behavioural change perspective the *Public Transport Advocates* and *Environmental Champions* are perhaps less of a priority given that they already exhibit the desired behaviour. They are also relatively fewer in terms of overall group membership. In the case of the *Public Transport Advocates*, their mode choice options are also limited by the fact that they do not have access to a car.

This leaves the *Conflicted Greens* and the *Pessimistic Lift Seekers* as groups where there is possibly scope for reducing private vehicle use. These two groups are interesting from a behavioural change perspective as they are located more on the behavioural margins of the sample; unlike the other groups they do not exhibit a particularly strong preference for any mode. As noted by Anable et al. (2006), the greatest potential for behavioural change is often at the margins where attitudes tend to be more malleable and susceptible to influence.

The *Conflicted Greens* represent 9.2% of passengers in the sample overall. While they have the most favourable attitudes towards public transport in the sample, only 56.4% of these passengers actually travelled by public transport on the day of the survey; the remaining 43.6% travelled either by drop-off or taxi. It would appear that there is not a pressing need to address the underlying attitudes or future intentions of the group, rather the manifestation of these attitudes in terms of actual mode choice. There appears to be a disparity between the groups attitudes and their subsequent behaviour, in other words this group do not always act in accordance with their underlying attitudes and intentions. One possible option that could be used to try and reduce the size of the apparent 'gap' between their attitude and behaviour would be to continually reinforce the benefits of travelling by public transport and provide incentives to try and make sure that passengers behave in the desired fashion. This could take the form of loyalty points, vouchers, discounts or some other form of financial incentive measure. It is likely that the *Conflicted Greens* would respond better to such an initiative than the other groups, given their underlying favourable view of public transport.

The *Pessimistic Lift Seekers,* who represent 11.3% of passengers in the survey, pose a slightly different challenge. As Table 8.6 showed, this group is largely composed of drop-off and taxi users. Attitudes to using public transport are the most negative of all the clusters, which is reflected by the fact that not a single passenger in the group used public transport for their trip to the airport. Their outlook and subsequent behaviour is in stark contrast to the other non-car access cluster, the

Public Transport Advocates. Responses to attitude statements and scores for psychological constructs suggest that the disparity in behaviour between the two groups may stem from their varying perceptions of the ease/ difficulty of using different modes (perceived behavioural control). Namely, the *Pessimistic Lift Seekers* generally perceive using public transport to be prohibitively difficult, while they consider using taxis and drop-off to be much easier. The *Public Transport Advocates,* on the other hand, consider public transport to be relatively easy to use.

The disparity in perceived behavioural control for these two groups is shown in Figure 8.6. Average scores for items measuring perceived behavioural control for public transport (PBC PT), train (PBC TRAIN), bus (PBC BUS), drop-off (PBC DROP OFF), and taxi (PBC TAXI) are shown for both the *Pessimistic Lift Seekers* and the *Public Transport Advocates*. As can be seen, the *Pessimistic Lift Seekers* generally perceive using public transport to be prohibitively difficult (lower scores), while they consider using taxis and drop-off to be much easier (higher scores). For the *Public Transport Advocates,* on the other hand, the opposite is true.

In terms of future strategies, it would seem that an important goal for the *Pessimistic Lift Seekers* is to reduce the barriers that they perceive to exist currently preventing them from using alternatives to private vehicles. While it would be necessary to investigate the specific nature of these perceived barriers before putting any strategies in place, one possible solution might include offering free or reduced tickets for a short period so that they can experience using these modes. Considering that public transport use in this group is so low, it is quite possible that passengers have formed negative preconceptions about the difficulty of using public transport without actually using it. Providing an incentive to use public transport may therefore help to dispel these preconceptions.

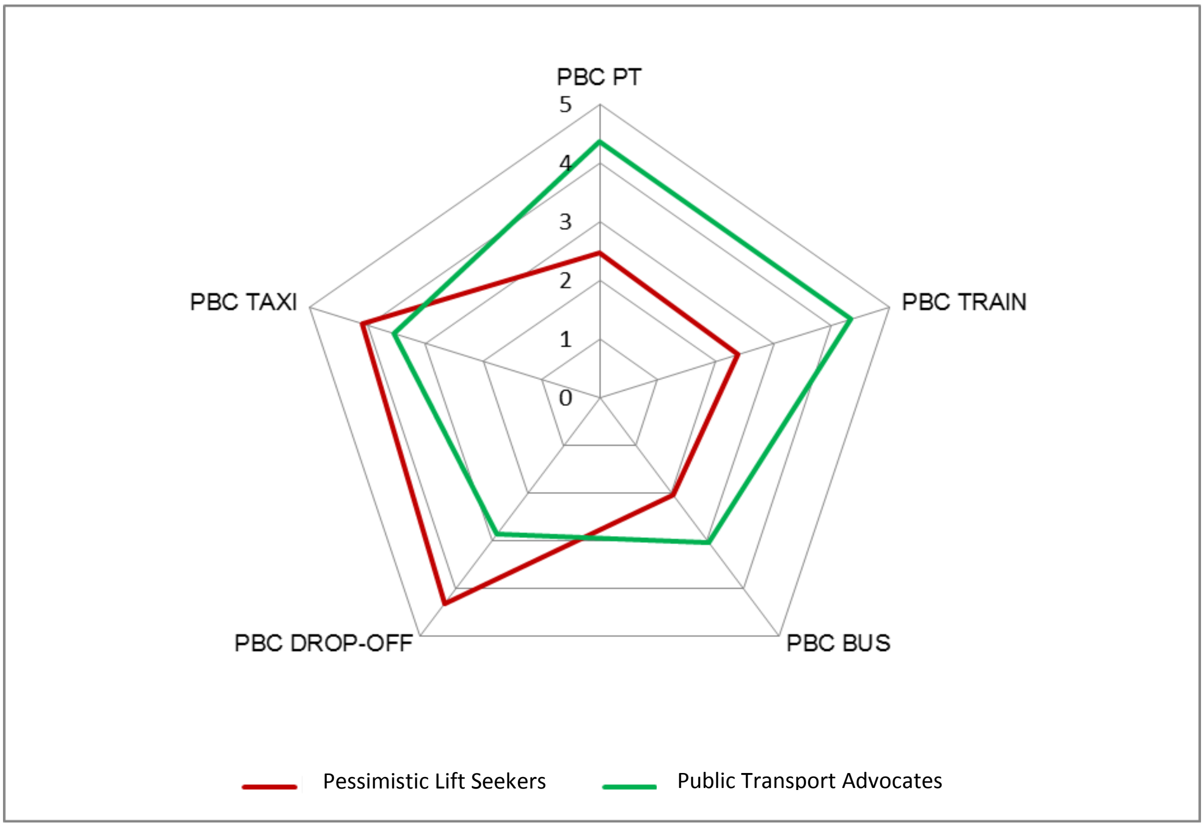


Figure 8.6 Comparison of average score for items referring to perceived behavioural control associated with different modes for the Pessimistic Lift Seekers and the Public Transport Advocates

Following the rationale that behavioural change initiatives are often most successful when they are targeted at the margins where attitudes are more malleable and susceptible to influence (Anable et al., 2006), the *Conflicted Greens* and the *Pessimistic Lift Seekers,* who together represent just over a fifth (20.5%) of passengers in the survey, were identified as groups where strategies could be used to reduce private vehicle use. For the *Conflicted Greens* the issue relates to reducing the attitude-behaviour ‘gap’ and trying to ensure that they behave in accordance with their underlying attitudes. In contrast, for the *Pessimistic Lift Seekers* the need to reduce the perceived difficulty of using alternative modes was identified as a key priority.

8.5 Conclusions

Chapter 8 sought to “determine segments of passengers with the greatest potential to reduce their private vehicle use (objective 5).” The whole premise of market segmentation from a strategy and policy perspective it is relatively futile to try to address the ‘average’ person. Instead, it is better to assess the shared needs, attitudes and perceptions of much smaller groups of individuals as they are likely to be motivated by different factors, hold varying attitudes towards the behaviour and thus experience different barriers to behavioural change.

With this in mind, in Section 8.3 eight distinct passengers segments were identified based on shared attitudinal and situational characteristics using cluster analysis. Eight clusters were identified, six for passengers with access to a car and two for passengers without. The six clusters with car access were defined predominantly by their varying attitudes towards using public transport and using the car. For example, the *Devoted Drivers* held very positive attitudes towards using the car and negative attitudes towards using public transport, whereas for the *Conflicted Greens* the opposite was true. Other groups were defined predominantly by their views towards a certain mode, the *Environmental Champions* and the *Ardent Taxi Users* for example were characterised by their attitudes towards the bus and taxi, respectively. With the exception of the *Complacent Motorists,* there was relatively little variation between the groups in terms of the perceived social pressure they felt to behave in a certain way or any feelings of personal moral obligation.

The two non-car access clusters, the *Pessimistic Lift Seekers* and the *Public Transport Advocates,* were defined from each other by their markedly different views regarding the use of drop-off and public transport, and, as was subsequently discovered, the perceived difficulty with which they viewed using different modes.

Groups were further found to be defined along issues of mode choice, group size and journey distance. Variations in mode choice largely reflected the attitudinal disposition of the group. Journey distance was shown to be an important factor for defining clusters that used taxis or drop-off; a larger share of passengers in the *Dogmatic Drop-offs* and the *Ardent Taxi Users* groups started their journey from areas closer to the airport than in other groups. Travel group size, on the other hand, differentiated clusters with high public transport use (for example, the *Environmental Champions* and the *Public Transport Advocates)*.

Ultimately, the purpose of the cluster analysis was to determine *"the potential of different passenger segments to reduce their private vehicle use (research question ix)."* Groups with the lowest potential to reduce private vehicle use were the *Ardent Taxi Users* and the *Devoted Drivers.* In this case the emphasis from an airport management perspective is more about ensuring that behaviour does not shift in a 'negative' direction, as realistically the chances of achieving modal shift towards public transport use for these groups is fairly low.

The *Complacent Motorist* and *Dogmatic Drop-offs* also pose significant challenges in terms of reducing private vehicle use. For the former, there is a case for trying to convey the importance of individual travel decisions given that the behavioural efficacy for this group was generally low. The *Dogmatic Drop-offs*, as their name suggests, disputed the notion that car access to airports was a problem and showed little inclination to change their established patterns of behaviour. In this case it would seem that harder market-based disincentive measures would need to be considered if the airport was determined to reduce private vehicle use for this group.

The *Environmental Champions* and the *Public Transport Advocates* exhibited a high use of public transport, positive attitudes towards using alternative modes to private vehicles and had a strong intention to use them in the future. The focus for these passengers should be maintaining and improving current service levels of public transport services to try and sustain existing patterns of behaviour.

Following the rationale that behavioural change initiatives are often most successful when they are targeted at the margins where attitudes are more malleable and susceptible to influence (Anable et al., 2006), the *Conflicted Greens* and the *Pessimistic Lift Seekers* were identified as groups where strategies could be used to reduce private vehicle use. For the *Conflicted Greens* the barrier to reducing car use related to minimising the attitude-behaviour 'gap' and trying to ensure that they behaved in accordance with their underlying attitudes. In contrast, for the *Pessimistic Lift Seekers* the need to reduce the perceived difficulty of using alternatives to private vehicles was identified as a key priority.

Findings in Chapter 8 have shown the importance of segmentation analysis in identifying areas where behavioural change can be initiated, as well as highlighting the nature and scale of potential obstacles (either perceived or real) that are preventing people from behaving in a certain way. By examining the psychological nature of behavioural barriers and constraints it is then possible to develop targeted strategies and interventions to address them. The following chapter draws together the key research findings and proposed recommendations for both the future direction of airport surface access strategies and surface access research.

Chapter 9

Conclusions and recommendations

9.1 Introduction

The final chapter considers the significance of the research findings in light of the study context and their implications for policy. Initially, in Section 9.2, the findings of the research are summarised in the context of the objectives, research questions and the overall aim of the thesis. Section 9.3 then addresses the final research objective, “to make recommendations to airport decision makers concerning effective strategies for reducing private vehicle use (objective 6).” The contributions of the research to original knowledge are then discussed in Section 9.4. Limitations of the study are addressed in Section 9.5, before possible areas for future research are proposed in Section 9.6.

9.2 Summary of research findings

The objectives (1-6) and research questions (i-ix) were used to guide the aim of the thesis, “to examine passenger surface access travel behaviour in order to make recommendations for reducing private vehicle use”.

1. To identify key surface access issues.

A review of the literature was conducted in Chapter 2 to identify key surface access issues. This found that there is a need for airports to develop strategies for reducing the share of private vehicles journeys given that these trips generally constitute the majority of journeys at airports worldwide. The continued dominance of private vehicle journeys has led to increasing problems of congestion and associated negative environmental impacts relating to increased vehicle emissions. The problem of managing surface access is compounded by the varying requirements and characteristics of different airport users, balancing commercial and environmental goals, accounting for the geographic spread of surface access trips and remaining flexible to changes in external market conditions.

The literature review raised a number of important issues relevant to the research regarding how the nature and scale of surface access issues varies between airports, whether certain strategies are considered to be more effective than others in achieving reductions in private vehicle use, whether the surface access problem is generally considered to be improving or deteriorating, as well as likely directions for surface access policy in the future.

2. To understand the challenges, implications and future directions of surface access management.

Chapter 3 sought to address the issues raised in the literature review. Ten semi-structured interviews were subsequently conducted with key personnel responsible for surface access management at 14 UK airports.

i. How does the nature and scale of surface access issues vary between UK airports, are some issues unique to particular airports?

Airport size was found to play a key role in determining the nature and scale of surface access issues at an airport. For larger airports, problems relate largely to severe traffic congestion on airport roads and terminal forecourts, and the associated negative environmental impacts of increased vehicle emissions. Provision of efficient, reliable public transport is also a major issue for these airports in terms of airport competition and extending the geographical extent of the catchment area.

Smaller airports tend to face different challenges. While passenger car parking plays an important role for airports, it is perhaps especially vital for smaller airports given their lower passenger numbers, and the fact that these revenues will often help to subsidise bus services to and from the airport. Smaller airports also face significant challenges in encouraging public transport use as they typically do not have the required passenger numbers to support regular services.

The need to reduce the share of drop-off/pick-up trips is a problem common to virtually all airports. For larger airports these journeys pose problems in terms of extra traffic generation and congestion on airport roads and lack of curb side capacity. Drop-off and pick-up journeys are also detrimental from a revenue perspective because passengers do not pay car parking fees. The potential negative economic impact of these journeys is what forms the primary cause for concern among smaller airports, who are perhaps less concerned by problems of congestion but are acutely aware of the negative commercial impacts these trips have. Consequently, the need to reduce drop-off/pick-up trips is of significant importance to airports in the UK.

ii. Are certain strategies considered to be more effective or preferred by airport managers than others?

Airport managers appear to favour using ‘softer’ incentive measures rather than ‘harder’ disincentives, which risk being unpopular with airport users and may lead them to choose other airports in the future. While yield management of passenger car parking costs is a market based measure employed at almost all airports, it is considered primarily as a means of revenue generation rather than as a demand management measure. With regards to passenger access, the tendency to favour 'carrots' rather than 'sticks' is driven by considerations of customer service/perceptions and airport competition, whereas for employees it is more about maintaining good staff relations.

iii. What are the likely future directions of surface access policy?

While operational measures, physical improvements and market-based measures will continue to be valuable strategic options for airport managers with regards to surface access, large scale infrastructure projects are unfeasible for many airports given the high cost and timescales of these projects, especially in the current economic climate. Subsequently, there is a growing recognition of the need to tackle the root causes of the surface access problem by examining the underlying determinants of peoples travel behaviour and understanding the factors that govern mode choice. It is thought that future strategies are likely to stand the greatest chance of success when they are targeted at specific groups of airport users or market segments who share similar characteristics and the potential to change their behaviour.

3. To assess the personal, situational and spatial characteristics of passenger mode choice.

Chapters 6 investigated the wide range of factors affecting passenger mode choice. .

iv. Do the factors motivating passenger mode choice vary for different modes?

Responses to an open ended question in the questionnaire largely supported the notion that passenger mode choice is a product of perceptions about the relative cost, comfort and convenience of different modes, as posited by Ashford et al. 2013. The relative importance of these factors varied between modes. Comfort and convenience factors were important for car and taxi users, whereas the decision to be dropped-off was motivated primarily by cost considerations. As well as cost, comfort and convenience, journey speed and the availability of a mode were shown to be significant considerations for passenger travelling by public transport.

v. How are the personal, situational and spatial characteristics of passenger surface access travel expressed in terms of mode choice?

The various personal, situational and spatial dimensions of passenger mode choice were analysed using descriptive analytical techniques and GIS mapping in Chapter 6. This information was then used to develop a typology of surface access passengers using multinomial logistic regression.

This process showed that there are clear differences between public transport users and private vehicle users in terms of their situational and spatial characteristics. Public transport users were shown to be strongly characterised by travelling alone, and were less likely to be carrying checked-in luggage with them. In comparison with drop-off and taxi users, passengers travelling by public transport were also more likely to have a longer surface access journey to the airport.

Car users, on the other hand, were found to be likely to have access to a car, be travelling on business, accessing the airport early in the morning and flying on the outbound leg of their journey. Passengers who were dropped-off at the airport were also likely to have access to a car, but were more likely to be starting their journey from home and travelling a shorter distance to the airport. Taxi users were likely to be travelling for business purposes and accessing the airport in the early morning peak period. They were also likely to be travelling only a relatively short distance to the airport.

4. To evaluate the psychological determinants of decisions to travel by alternative modes to private vehicles.

The psychological and attitudinal antecedents of mode choice were then examined in Chapter 7. Tests of two contrasting theories of attitude-behaviour relations, the Norm-Activation Theory (Schwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991), as well as two combined models, were conducted using structural equation modelling.

vi. Are decisions to travel by alternative modes to private vehicles guided predominantly by moral and normative influences or by considerations of personal utility and self-interest?

Tests of the Norm-Activation Theory (Scwartz, 1977) and the Theory of Planned Behaviour (Ajzen, 1991) found that decisions about travelling to the airport are guided predominantly by considerations of personal utility and self-interest, as posited in the Theory of Planned Behaviour (Ajzen, 1991). Indeed, the extent to which the concept of intention (from the Theory of Planned Behaviour) explained the variance in mode choice was notably higher than in other similar studies (for example, Bamberg et al., 2007), indicating that surface access travel is perhaps even more of a personally guided, selfish form of travel behaviour than other journeys.

vii. Is a combined theoretical approach more appropriate than either the Theory of Planned Behaviour or the Norm-Activation Theory in their original forms when explaining decisions to travel by alternative modes to airports?

vii. Are measures of anticipated feelings of guilt, descriptive norm and behavioural efficacy useful additional predictors of decisions to travel by alternative modes to airports?

Two combined theoretical models incorporating elements of the Norm-Activation Theory, the Theory of Planned Behaviour and three additional psychological constructs were tested. Overall, the tests provided only limited support for the use of the combined theoretical approach in a surface access context, and each of the additional constructs were not found to be useful additional predictors of behaviour.

5. To determine segments of passengers with the greatest potential to reduce their private vehicle use.

Chapter 8 than considered the idea of group profiling or market segmentation, and investigated whether it was possible to determine segments of passengers most amenable to behavioural change.

ix. *What is the potential of different passenger segments to reduce their private vehicle use?*

Cluster analysis was used to identify eight behaviourally distinct groups based on various trip related and attitudinal characteristics. Of the 8 groups, four showed a low or very low potential to reduce their private vehicle use. These groups were described as the *Complacent Motorists, Dogmatic Drop-Offs, Ardent Taxi Users* and *Devoted Drivers*. Two groups, the *Environmental Champions* and the *Public Transport Advocates*, already exhibited high public transport use and strong positive attitudes towards using it in the future. Following the rationale that behavioural change is often most likely that the behavioural ‘margins’ (Anable et al, 2006), two groups were subsequently identified as having the greatest potential to reduce their private vehicle use, the *Conflicted Greens* and the *Pessimistic Lift Seekers.* Together, these two groups accounted for just over a fifth (20.5%) of passengers in the survey.

For the *Conflicted Greens* there is an apparent ‘gap’ existing between their positive attitudes towards public transport and their ultimate mode choice. For this group there is subsequently a need to minimise the attitude-behaviour ‘gap’ and to ensure that they behave in accordance with their underlying attitudes. In contrast, for the *Pessimistic List Seekers* the barriers to increasing public transport use are more to do with the perceived difficulty with which they view using these modes. Consequently, the need to reduce the perceived difficulty of using alternatives to private vehicles is a key priority for this group.

9.4 Policy recommendations

Consideration of objectives 1-5 thus enable the last objective to be addressed.

> 6. To make recommendations to airport decision makers concerning effective strategies for reducing private vehicle use.

Consequently, in this section a number of recommendations are made in light of the research findings.

The social psychological approach adopted in the research has demonstrated the value of accounting for an individual's psychology and attitudes in understanding their travel decisions. Identifying the disparity between a person's attitudes, intentions, and behaviour also lends further support to the argument that decisions about travel behaviour are not solely based on rational evaluations of factors such as time and cost. Consequently, it is important that transport policies in general account for individual attitudes and perceived capabilities and constraints when making travel decisions.

The point about a person's perceived capabilities and barriers is an important one. To elaborate, as noted by Stradling et al. (2000), while comprehension of a person's attitudes is a useful guide to their future behaviour, given the link between attitude and intention, it is not entirely infallible. Decision makers must recognise that both real *and* perceived barriers to behaviour act as filters between the intention to behave in a certain way, and the behaviour itself. In many instances the perceived barriers are as important, if not more so, that the so-called 'real' barriers. Seeking to identify, and then reduce or remove psychological barriers to behaviour should be a key aspect of policies designed to reduce private vehicle use.

An example of this from the present research is the *Pessimistic Lift Seekers* and the *'Conflicted Greens'* groups, as identified in Chapter 8. In the case of the *Pessimistic Lift Seekers* a barrier to reducing private vehicle use appeared to be the perceived difficulty of using alternative modes of transport (see Figure 8.2), and as such efforts could be made to emphasise the ease of using public transport for this group. The

Conflicted Greens, on the other hand, exhibited positive attitudes towards using public transport, yet actually favoured private vehicle modes. It was not the attitudes of this group that needed addressing but the conversion of these attitudes into actual public transport use. Here it would be appropriate for managers to provide information about the positive impacts of switching modes, both for the user and for the situation in general.

Addressing the various psychological barriers impeding behaviour is clearly a challenging prospect, yet there are numerous examples of successful behavioural change initiatives for airport decision makers to draw upon. Efforts should therefore be exerted to benefit from the experience, expertise and examples of best practice from a wide range of fields and domains, not just transport and travel behaviour. Reticence to change ones travel behaviour likely shares a number of similarities with other areas where identifying and reducing psychological barriers is seen as a key factor in achieving behavioural change. Consequently, there is a case for drawing upon the expertise and knowledge gained in other behavioural change areas to help tackle the surface access problem.

It also recommended that airports place a greater emphasis on benchmarking, collaborating and sharing best practice not just with other airports (although this is important), but also with other sectors and industries such as hospitals, shopping centres or universities, places that often face similar challenges to airports in terms of attracting high private vehicle use and trying to encourage modal shift.

As found during the interviews with airport managers, given that yield management of passenger car parking is seen as a form of revenue generation, there is a preference for providing incentives (carrots) to reduce private vehicle use rather than disincentives (sticks). Although the acceptance of different policy measures was not explicitly measured in the questionnaire, it would seem fairly safe to assume that passengers are likely to react more positively to policies that reward them for using public transport, rather than reprimand them for using private vehicles. Support for such an approach would be provided from similar findings in previous travel behaviour research, such as Tertoolen et al. (1998) and Zhang et al. (2013), as discussed in Section 4.7.

Rewarding passengers for reducing their private vehicle use need not necessarily be in the form of financial incentives, but instead reward could be provided in the shape of regular, reliable and affordable services that meet the needs and requirements of passengers (see Section 2.3.1). While acknowledging the numerous challenges associated with the current state of the economy, the highly competitive nature of the airport sector in the UK, and the limited influence airports have over transport operators and providers (see Section 3.3.3), it is important, indeed *vital*, that mutually beneficial business relationships can be established between airport decision makers and stakeholders so that services are provided that meet the needs of the people using them.

Providing people with the opportunity, or the context, in which to make the desired or ‘right’ choice is a fundamental aspect of facilitating behavioural change. As stated in the report published by the House of Lords Science and Technology Committee into behavioural change (see Section 2.2), if the options available to travellers are limited or the services themselves are inadequate, then no matter how well the psychological barriers are tackled or other policies put in place, it is unlikely that the desired outcomes will be achieved. This relies to a significant extent on the provision of key infrastructure, which can be considered as both a prerequisite for, and a great enhancer of, behavioural change strategies. It is subsequently vital that behavioural change strategies are adequately and continuously supported by the provision and development of key surface access infrastructure, it is not a case of having one at the expense of the other.

The extent to which reductions in private vehicle use can be achieved, and the types of strategies needed for achieving this, largely depend on the time scales involved. As reported in Section 2.2, currently ASAS and ATFs are required to set targets for decreasing the share of private vehicle journeys and increasing public transport in the short and long term (DETR, 1998). From the passenger segments defined in Chapter 8, there appears to be a relatively small, yet significant, share of passengers with the potential to reduce their private vehicle use in the shorter term. Groups such as the *Conflicted Greens* and *Pessimistic Lift Seekers* occupy what Anable et al. (2006) refer to as the behavioural 'margins', where people are arguably most malleable to change. As resistance to change for this group is lower than for other groups, achieving incremental change in behaviour, as referred to in Section 5.3.1, would seem a distinct possibility for these passengers. This is perhaps where 'soft' incentive measures, as addressed by Cairns et al. (1998), may be most effective.

For the majority of people, however, there is a much stronger resistance to change. Consequently, in the longer term it is unlikely that continuing to 'chip away' at the behavioural margins will be enough to yield the long lasting, significant shifts in behaviour that are needed to meet targets for reducing private vehicle journeys set out in ASAS. Instead, it will eventually become necessary to address the behaviour of this significant, more resistant, majority of people. In other words, decision makers will eventually need to confront the substantial challenge of encouraging behavioural change for the people who fall into the *'Dogmatic Drop-offs'* or *'Devoted Drivers'* categories, rather than just being satisfied to achieve small incremental changes elsewhere. While airport decision makers may favour 'softer' incentive measures as opposed to 'harder' fiscal disincentive measures (see Section 3.3.4), in the future it is increasingly likely that greater consideration will need to be given to market-based and regulatory interventions.

While much of the focus in travel behaviour research in recent years (and in this thesis) has been on the act of actually initiating behavioural change, it is important that focus is not entirely drawn away from putting mechanisms in place to help assist and maintain behaviour once it has changed to ensure that people do not revert back to private vehicle use. In other words, airport decision makers should remain prudent of the fact that people can as easily (if not more easily) move 'down' the hierarchy of preferred modes as they can move 'up' it. In the same way that businesses must balance the demands of satisfying their existing customers with trying to attract new ones, airports must continue to positively reinforce the decisions of people who choose to use public transport and not take it for granted that people who currently use public transport will always continue to do so.

In summary, the research undertaken makes a number of recommendations to airport decision makers for reducing private vehicle journeys to airports, thus fulfilling the sixth research objective and the overall aim of the thesis.

- strategies must account for both actual and perceived barriers impeding decisions to use alternative modes to private vehicles.
- emphasis must be placed on how easy it is to use alternative modes to private vehicles, given that perceived difficulty was found to be a key barrier to behavioural change.
- information should be provided about the positive impacts of reducing private vehicle use, and demonstrate the benefits this will have both for the individual and overall.
- draw upon the experience, expertise and examples of best practice gathered from a wide range of behavioural change domains and other sectors.
- generally it is better to reward passengers for making positive choices rather than reprimanding them for negative ones.
- suitable infrastructure is a prerequisite for, and greatly enhances the effectiveness of, behavioural change initiatives. If viable travel options are not available to passengers then behavioural change strategies will likely fail.
- focusing on behavioural change of passengers currently travelling by private vehicles should not be at the expense of ensuring that people who currently travel by alternative modes continue to do so in the future.

While it should be noted that these recommendations are formed from the basis of a single study, which inevitably cannot entirely account for the myriad of interconnecting factors relating to attitudes, perceptions, information, knowledge, past behaviour, interpersonal relationships, social norms and contextual circumstances that shape a person's travel behaviour, the research does provide a number of valuable contributions to knowledge both in terms of surface access travel and for travel behaviour research more generally.

9.4 Contributions to original knowledge

Given the severity of the airport surface access problem (see Section 1.2), the aim of the research was thus to "examine passenger surface access travel behaviour in order to make recommendations for reducing private vehicle use." This section details the contributions to original knowledge that have been made in achieving this aim.

9.4.1 Gaining an airport management perspective

While the review of the literature (Chapter 2) indicated the need for airport managers to deliver strategies for reducing private vehicle trips, there were relatively few examples of studies that had directly engaged the views of airport managers in this matter. The semi-structured interviews conducted with airport managers, as reported in Chapter 3, were valuable in that they helped identify issues that were not evident using the literature alone.

A key finding of these stakeholder interviews was the degree to which the 'surface access problem' means very different things for different airports. At larger airports, where passenger numbers are generally higher, challenges associated with traffic congestion on and around the airport site are widespread, with associated increased environmental impacts in terms of diminished local air quality and harmful atmospheric emissions. For smaller airports, on the other hand, congestion is generally less of a problem given the lower passenger numbers, but instead these airports must maximise the limited revenue potential of passenger car parking in order to remain commercially viable. Smaller airports also face challenges because they typically do not possess the required passenger numbers needed to support regular public transport services.

9.4.2 The importance of attitudes and perceptions in mode choice and the propensity to reduce private vehicle use

Research findings have built on existing surface access studies by investigating the role of an individual's attitudes and perceptions in mode choice. Rather than focusing exclusively on the role of personal, situational and spatial factors, although this was covered in Chapter 6, the research took a social psychological approach to examining surface access travel behaviour. Beyond successfully identifying the factors associated with the use of different modes, the research was able to identify people with the most (and least) potential to reduce their private vehicle use. This is significant for decision makers, as a better understanding of the motivations underlying *why* people behave in a certain way, rather than merely explaining *how* they do it, is inevitably a vital part of initiating behavioural change.

The social psychological approach adopted in this thesis also enabled a deeper understanding of the psychological barriers associated with switching to modes other than private vehicles. While for some people the issue relates to the perceived difficulty of using these modes, for others there appears to be a strong preference for, and positive attitude towards, private vehicle journeys. This makes the prospect of encouraging reductions in private vehicle use for these people more challenging.

9.4.3 Extending the application of the Norm-Activation Theory and the Theory of Planned Behaviour to a new context

As well as making important empirical contributions the research has also made important contributions to theoretical understanding, both in terms of the Norm-Activation Theory and the Theory of Planned Behaviour specifically, and psychological theories of attitude-behaviour relations in general. As the breadth of literature discussed in Chapter 4 shows, while both the Norm-Activation Theory and the Theory of Planned Behaviour have both received empirical evidence in support of their use in travel behaviour research, it is notable that neither have been applied in a surface access context, or indeed one where the journey in question is not a frequent ‘every day’ journey that is made regularly.

The characteristics of surface access journeys are unusual in that passengers are likely to be staying away for a period of time, travelling in groups, carrying heavy luggage with them and may be dropped-off/picked-up (Ashford et al., 2013). Subsequently, the research is valuable in that it has demonstrated that the application of social psychological theories of attitude behaviour relations such as the Norm-Activation Theory and the Theory of Planned Behaviour can be extended to include unusual, or atypical, forms of travel. This has implications for the application of these theories in other, more specialised, journey contexts.

9.4.4 The use of a combined theoretical approach and additional psychological determinants of behaviour.

As discussed in Section 4.5, the use of a combined theoretical approach incorporating elements of both the Norm-Activation Theory and the Theory of

Planned Behaviour has received support in recent years (see Harland et al., 1999; Bamberg et al., 2007; Gardner and Abraham., 2010). The combined theoretical approach developed largely from the idea that travel behaviour is guided by both moral, normative factors and considerations of self-interest.

The present research has added to this debate by testing two combined theoretical frameworks proposed by Bamberg et al. (2007) and Gardner and Abraham. (2010), respectively. In the case of the model proposed by Bamberg et al. (2007), the conceptualised theoretical framework outperformed both the Norm-Activation Theory and the Theory of Planned Behaviour in their original form, thus lending further support to the use of combined theoretical approaches in travel behaviour research in the future.

As noted in Section 4.6, the ability to add additional psychological constructs to both the Norm-Activation Theory and the Theory of Planned Behaviour is one of their strengths. Consequently, in recent years a small, yet growing, number of studies have attempted to improve the performance of the two theories by including additional psychological constructs (see Heath and Gifford., 2002; Anable, 2005; Bamberg et al., 2007). Although evidence from the (admittedly small) existing body of evidence generally supported the use of constructs relating to descriptive norm, behavioural efficacy and anticipated feelings of guilt, findings from this research do not support the use of these constructs in the context of surface access travel. Their poor predictive ability likely reflects the fact that normative and moral factors (i.e. from the Norm-Activation Theory) were not strongly associated with surface access mode choice.

9.5 Limitations of the research

While the research has enabled recommendations to be made regarding the reduction of private vehicle journeys and provided valuable contributions to both empirical and theoretical knowledge, inevitably some concessions had to be made about the breadth and depth of the study. As is commonly the case with questionnaire surveys such as this one, to an extent they can only ever represent a certain 'snapshot' in time, however in depth and detailed this may be. In the case of the present research, inevitable time and cost constraints meant that it was only possible to sample passengers for a relatively short period of time, and only at one airport. While it was considered desirable to sample passengers at a large UK airport, for the reasons provided in Section 5.3.1, ideally it would have been preferable to include passengers at a wider range of airports and for a much longer period of time. This would not only have allowed longitudinal comparisons to be made through time, but also between different types of airports. Again, although not feasible in the present research, it would also have been preferable to sample a much greater number of passengers.

The approach taken here also potentially engenders problems relating to the transferability of research findings, given that the study is predominantly UK focused. While undoubtedly there are things that differentiate the surface access situation in the UK from other countries, such as the legal requirement to formulate ASAS and patterns of airport ownership, the problems associated with airports attracting high volumes of private vehicle trips and the subsequent need to reduce these journeys for environmental reasons is not unique in a UK context. Consequently, while the findings and recommendations found in this study should not be treated as a 'one-size-fits-all' solution, they have benefit for decision makers at airports worldwide.

9.6 Further research

The research also helped to highlight a number of possible avenues for future research.

9.6.1 Evaluation of behavioural change policies

Thorough and systematic evaluation of proposed behavioural change policies is a highly important factor determining their success or failure, as it allows them to be continually monitored, assessed, and modified or discarded as required. Future research projects could play a valuable role in assessing the extent to which strategies were effective in achieving their goals. For example, with reference to the *Pessimistic Lift Seekers* group, a longitudinal study could be conducted to assess the extent to which attempts to reduce the perceived difficulty of using public transport had been successful.

Another important issue relates to the extent to which policies targeted at one area have knock-on effects elsewhere, the so-called 'domino effect'. The highly interconnected nature of the airport system means that the impacts of policies are unlikely to be confined to one particular area. For example, it would be beneficial to evaluate to what extent policies such as drop-off charges actually reduce the use of this mode rather than simply moving the problem elsewhere, or introduce an entirely new problem that had not previously been considered. This is important as it is possible that in some cases a strategy that appears to successfully tackle one issue may have unintended impacts somewhere else.

9.6.2 Perceptions of surface access as part of the whole trip

Surface access travel is unusual in that typically it represents only part of a much longer (and generally more expensive) journey. As a result it is difficult to view surface access travel in isolation in the same way that, say, the journey to work can be. For example, a passenger flying on a long-haul flight will likely have already spent many hundreds of pounds on their air fare and accommodation at their destination. For these passengers, their surface access journey may represent only a fraction of the total time and cost expenditure of their trip. In comparison, for a passenger flying on a low-cost short-haul flight their surface access journey may represent a sizeable share of their total trip. As a result, the perceptions of these two trips with regards to surface access travel are likely to be different.

The interaction between flying with low-cost carriers and surface access travel, in particular, is an interesting case that warrants further research. Although surface access managers did not feel that passengers travelling with low-cost carriers were more likely to travel further to the airport than other passengers (see Section 3.3.3), as had been suggested in the literature (for example, Barrett, 2000; Dennis, 2004; Pantazis and Liefner, 2006; Lian and Rønnevik, 2011), it *was* felt that the nature of low-cost air travel, and particularly the idea that these passengers were less likely to be travelling with luggage, may have an impact on their surface access behaviour. Given the scale of low cost operations in the UK, research examining how, if at all, travelling on low-cost carriers impacts surface access travel behaviour would be of significant value.

Furthermore, it is also interesting that when passengers travel to airports they are doing so with the explicit intention of then going on to undertake an activity that in itself is widely regarded as being environmentally damaging (i.e. flying). In most cases the surface access portion of a passenger's trip will only represent a small fraction of their emissions for the entire journey. It therefore seems quite likely that this juxtaposition between surface and air travel would affect people's perceptions and attitudes towards the former. Establishing the nature of this would form a valuable area for future research.

As the research has shown, airport surface access is a complex and demanding issue, both in terms of its impact for the airport in question and its environmental role more generally. The challenges faced by airports in terms of meeting the needs and requirements of different airport users, reconciling the often conflicting interests of commercial and environmental goals, and, in particular, reducing the reliance on private vehicle journeys are considerable and, in all likelihood, will remain a key aspect of surface access management for the foreseeable future. This is especially the case given the forecasted growth in demand for air travel (Humphreys and Ison, 2005).

Appendix A: Interview analysis sheet

Interview Analysis Sheet

Participant: [redacted]

Role: Head of Transport Planning and Policy, [redacted]

Date: 18/8/10

Location: Costa Coffee Arrivals, [redacted]

Key Points: - No valid, universal policy on aviation is present at the moment, aviation is in a state of policy flux, new coalition gov etc. This was seen as the key issue in UK aviation.
- Immigration queues a problem at [redacted]
- Priority for [redacted] is replacing rolling stock on trains
- There is a misconception of aviation as the biggest cause of climate change/environmental problems.
- Air Passenger duty important - was not elaborated on.
- Parking enforcement is a major issue [redacted] have to pay for parking management but the money from fines etc goes to the government.
- Kiss and Fly is a major concern in terms of trip generation and security. [redacted] only allow drop off, not pick up.
- Surface access decisions are based around planning for future capacity. [redacted]

Similarities:
- Firemen + Ground handlers seem to be the core cyclists.
- Buses better for staff travel than trains
- K+F a major environmental challenge in the future.

Differences: - The economic situation was scarcely mentioned, which contrasts greatly with other interviews.
- LCC are a positive influence on public transport mode share as they promote public transport on flights/websites
- Had concerns for monitoring traffic flow on surrounding roads

Problems:

Implications:

Appendix B: Copy of passenger questionnaire

Interviewer: ___________________________________ Date of interview____________

Start time of interview	:	End time of interview	:	Please use 24hr clock

Manchester Airport Passenger Questionnaire Survey (KGS 5346)

We are conducting some research for Loughborough University about travel behaviour and we would like to ask you about your attitudes and opinions. The information will be fed back to the aviation industry, so it's your chance to make your views known. Would you be able to spare 15 minutes to fill in a questionnaire please?

Qualifying question

Are you connecting from another flight?

If 'Yes': *terminate questionnaire*	1
If 'No': go to **Q1**	2

SECTION A: Questions about the surface access trip to Manchester Airport

Q1. Where did you start your journey to Manchester Airport today?

Home/place of normal residence	1	*Go to* ***Q2***
Place of work	2	
Friend/relative's house	3	
Hotel (not at the airport)	4	
Other (write in)	5	

Airport hotel	6	*Go to* ***Q1a***

Q1a Where did you start your journey to the airport hotel?

Home/place of normal residence	1	*Go to* ***Q2***
Place of work	2	
Friend/relative's house	3	
Hotel (not at the airport)	4	
Other (write in)	5	

Airport hotel	6	*Go to* ***Q1a***

ASK ALL

Q2. Where in the UK is this address?
Postcode…………………………………………………………………………………....
or
Name of town, hotel, offices etc *(write in)*……………………………………………......

SHOW CARD A

Q3. What was the main method of transport you used to get to the airport/airport hotel?

1 Car driver	1	Go to **Q3a**
2 Car passenger	2	
3 Dropped-off in a car	3	Go to **Q3b**
4 Bus or coach	4	Go to **Q3c**
5 Train	5	Go to **Q4**
6 Taxi or minicab	6	
7 Rental car	7	
8 Other *(write in)*	8	

Q3a). SHOW CARD B

Where did you park your car?

Short stay	1	Long stay (on Airport)	2	Long stay (off-Airport)	3
Hotel car park	4	Valet/meet and Greet	5	Don't know	6

Other (write in)……………………………………………………………………

Go to Q4

Q3b). Who was the driver of the car?

Friend/relative	1	Airline chauffeur service	2	Other*(state)*	3

Go to Q4

Q3c). SHOW CARD C

What type of bus/coach service did you use?

Local service bus	1	National or regional coach service	2
Tour operator coach	3	Courtesy bus from airport car park/hotel	4
Don't know	5	Other *(write in)*	6

Go to Q4

ASK ALL

Q4. Could you briefly describe why you chose this way of travelling to the airport?

………

………

SHOW CARD D

Q5. Approximately how long did your journey to the airport today take?

Less than 10mins	1	11-30mins	2	31-60mins	3
1-2hrs	4	2-3hrs	5	Over 3hrs	6

SHOW CARD E

Q6. How satisfied were you with the method of travel you chose to get to the airport today?

Very satisfied	5
Satisfied	4
Unsure	3
Dissatisfied	2
Very dissatisfied	1

Q7. Is this flight the outbound or return leg of your trip?

Outbound	1	*Go to* ***Q8***
Return	2	*Go to* ***Q9***

Q8. Once you return from your trip, do you intend to leave the airport by the same method of transport you used today?

Yes ☐
No *(please specify by which method)*……………………………………………………………………….

ASK ALL

SHOW CARD F

Q9. How often, if at all, do you use each of the following methods of travel for <u>any</u> kind of journey?

Rotate and tick start	**1** 5 or more days per week	**2** 2- 4 days per week	**3** Once a week	**4** Once a fortnight	**5** Once a month	**6** Between once a month to once a year	**7** Less than once a year	**8** Never
Car (driver)	1	2	3	4	5	6	7	8
Car (passenger)	1	2	3	4	5	6	7	8
Walk (>15mins)	1	2	3	4	5	6	7	8
Bicycle	1	2	3	4	5	6	7	8
Bus	1	2	3	4	5	6	7	8
Train	1	2	3	4	5	6	7	8
Taxi	1	2	3	4	5	6	7	8

<u>SECTION B: Questions about the current flight</u>

Q10. Where are you flying to today (final destination airport)?......................................

Q11. What is your flight number?...

Q12. What is your departure time?...

SHOW CARD G

Q13. What is the chief purpose of your trip?

Leisure		**Business**	
Holiday: fare paid separately	1	Commuting to work	7
Holiday: package	2	Attending internal company business	8
Visiting friends and relatives	3	Conference/trade fair	9
Cultural/sports events	4	Meeting with customers/suppliers	10
Going to live abroad	5	University/college education	11
Other *(write in)*	6	Other (*write in)*	12

Q14. How long will you be/have you been away for? *(wording dependent on answer to Q7)*

Weeks………………Days……………….Hours *(if less than 1 day*) ………………

Q15. Including yourself, how many people are travelling in your group?

…………………………… *if travelling alone, go to **Q16***

Q15a. Are you travelling with any children aged 4 years or under?

Yes ☐
No ☐

Q15b. Are you travelling with anyone who has limited mobility?

Yes ☐
No ☐

ASK ALL

Q16. As an individual, how many items of luggage are you travelling with today?

Checked-in……………………
Hand luggage…………………

Q17. Could you briefly describe why you chose to fly from Manchester Airport today?

……

…….

Q18. Excluding today's flight, how many times have you flown from Manchester Airport in the last 12 months?

……………….time(s)

Q19. a). Excluding today's flight, how many return flights, either domestic or international, have you taken over the last 12 months <u>from any airport</u>?

………………. return flights *if zero, go to **Q20***

b). Of these return flights, how many were for leisure trips, and how many were for business trips?

Leisure trips…………………….

Business trips…………………..

SECTION C: Attitude statements

ASK ALL

SHOW CARD H

Q20. To what extent do you agree or disagree with the following statements?

ROTATE AND TICK START	**5** *Strongly agree*	**4** *Agree*	**3** *Neither agree or disagree*	**2** *Disagree*	**1** *Strongly disagree*
a). Private car access to airports is a major environmental problem.	5	4	3	2	1
b). There is an urgent need to reduce private car use to airports.	5	4	3	2	1
c). If I use public transport to get to the airport it will not make a difference because others will continue to use their private cars.	5	4	3	2	1

SHOW CARD I

Q21. For the majority of people you know, how often do they use their private car to get to the airport?

5. Always ☐ 4. Often ☐ 3. Sometimes ☐ 2. Rarely ☐ 1. Never ☐

Q22. Do you have regular access in the UK to a private car, either as a driver or a passenger?

Yes ☐ *go to **Q23***
No ☐ *go to **Q24***

SHOW CARD J

Q23. To what extent do you agree or disagree with the following statements?

ROTATE AND TICK START	**5** *Strongly agree*	**4** *Agree*	**3** *Neither agree nor disagree*	**2** *Disagree*	**1** *Strongly disagree*
a). When I use my car to get to the airport, exhaust gases are emitted which have a negative effect on the global climate system.	5	4	3	2	1
b). I would feel guilty if I always used my car to get to the airport.	5	4	3	2	1
c). Using my car to get to the airport has a negative impact on other people.	5	4	3	2	1
d). Considering the environmental impacts of car use, I would feel guilty about using my car to get to the airport.	5	4	3	2	1
e). Because of my own values, I feel a personal obligation to use public transport instead of my car to get to the airport.	5	4	3	2	1
f). Regardless of what other people do, I feel morally obliged to use public transport instead of my car to get to the airport.	5	4	3	2	1

SECTION D: Attitudes to specific methods of transport at Manchester Airport

ASK ALL

SHOW CARD J

Please imagine that you are taking this trip again at some point in the next 12 months

Q24. To what extent do you agree or disagree with the following statements?

	5	**4**	**3**	**2**	**1**
ROTATE AND TICK START	*Strongly agree*	*Agree*	*Neither agree or disagree*	*Disagree*	*Strongly disagree*
a). For me, using public transport to get to Manchester Airport would be good.	5	4	3	2	1
b). People who are important to me would think I should use public transport to get to Manchester Airport.	5	4	3	2	1
c). For me, using public transport to get to Manchester Airport would be easy.	5	4	3	2	1
d). Using public transport to get to Manchester Airport would be unpleasant for me.	5	4	3	2	1
e) When I fly from Manchester Airport it is likely that I will use public transport.	5	4	3	2	1
f). I am confident that I could easily get to Manchester Airport by public transport.	5	4	3	2	1
g). Using public transport to get to Manchester Airport would be a pleasant experience for me.	5	4	3	2	1
h). I intend to use public transport to get to this airport the next time I fly from here.	5	4	3	2	1
i). I think people who are important to me would want me to use public transport to get to Manchester Airport.	5	4	3	2	1

For each of the following questions, please imagine that you are taking this trip again at some point in the next 12 months.

SHOW CARD K

Q25. How easy would it be for you to use the following methods of travel to get to Manchester Airport?

		5	**4**	**3**	**2**	**1**
ROTATE AND TICK START		*Very easy*	*Easy*	*Neither easy or difficult*	*Difficult*	*Very difficult*
Bus		5	4	3	2	1
Train		5	4	3	2	1
Car (driver or passenger)	N/A	5	4	3	2	1
Dropped-off in a car		5	4	3	2	1
Taxi		5	4	3	2	1

SHOW CARD L

Q26. To what extent do you agree or disagree with the following statements?

“When travelling to Manchester Airport, it would be good for me to…

		5	**4**	**3**	**2**	**1**
ROTATE AND TICK START		*Strongly agree*	*Agree*	*Neither agree or disagree*	*Disagree*	*Strongly disagree*
…use my car (driver or passenger).”	N/A	5	4	3	2	1
….be dropped-off in a car.”		5	4	3	2	1
…get a taxi.”		5	4	3	2	1
…get the bus.”		5	4	3	2	1
…get the train.”		5	4	3	2	1

SHOW CARD M

Q27. Would people who are important to you approve or disapprove of you using the following methods of travel to get to Manchester Airport?

		5	4	3	2	1
ROTATE AND TICK START		*Strongly approve*	*Somewhat approve*	*Neither approve or disapprove*	*Somewhat disapprove*	*Strongly disapprove*
Train		5	4	3	2	1
Taxi		5	4	3	2	1
Car (driver or passenger)	N/A	5	4	3	2	1
Dropped-off in a car		5	4	3	2	1
Bus		5	4	3	2	1

SHOW CARD N

Q28. To what extent do you agree or disagree with the following statements?

"When travelling to Manchester Airport, I would feel a strong moral obligation to…

		5	4	3	2	1
ROTATE AND TICK START		*Strongly agree*	*Agree*	*Neither agree or disagree*	*Disagree*	*Strongly disagree*
…get the bus."		5	4	3	2	1
…use my car (driver or passenger)."	N/A	5	4	3	2	1
…be dropped-off in a car."		5	4	3	2	1
…get the train."		5	4	3	2	1
…get a taxi."		5	4	3	2	1

SHOW CARD O

Q29. How likely is it that you would use the following methods of travel to get to Manchester Airport?

		5	4	3	2	1
ROTATE AND TICK START		*Very likely*	*Likely*	*Neither likely or unlikely*	*Unlikely*	*Very unlikely*
Car (driver or passenger)	N/A	5	4	3	2	1
Dropped-off in a car		5	4	3	2	1
Train		5	4	3	2	1
Taxi		5	4	3	2	1
Bus		5	4	3	2	1

<u>SECTION E: Sharing journeys to the airport</u>

SHOW CARD P

Q30. For each of the following methods of travel, how likely is it that you would choose to share a ride with other passengers, not in your travel group, to get to the airport?

		5	**4**	**3**	**2**	**1**
		Very likely	*Likely*	*Neither likely or unlikely*	*Unlikely*	*Very Unlikely*
Your private car	N/A	5	4	3	2	1
Someone else's private car		5	4	3	2	1
Taxi		5	4	3	2	1
Bus / coach service		5	4	3	2	1

Q31. What, if anything, would put you off sharing a journey to the airport with other passengers not in your travel group?

……..

……..

Q32. Are there any comments you would like to make about your journey to and from the airport?

……..

……..

<u>SECTION F: Socio-demographic information</u>

Q33. In which country have you mainly been living in over the last 12 months?

....

Q34. What nationality of passport do you hold?...

SHOW CARD Q

Q35. Which age category do you belong to?

18-24 ☐ 25-34☐ 35-44 ☐ 45-54 ☐
55-59 ☐ 60-64☐ 65-74 ☐ 75 + ☐

Gender of respondent

Male☐ Female☐

Terminal

T1 ☐ T2 ☐ T3 ☐

THANK YOU FOR YOUR TIME

Appendix C: Passenger questionnaire quota sheet

Loughborough University / ABC Project - Job No: 5346, QUOTA SHEET - 14 -16 Interviews

TERMINAL 1

Interviewer: ______________________ **Date:** _____ / _____ / 2011

Gender	Required	Achieved
Male	7-8	
Female	7-8	

Age spread		
Up to 34 years	5	
35-44	2-3	
45-64	6-7	
65+ years	1	

Purpose of trip		
Business	2-3	
Leisure	12-13	

Try to get a spread of destinations too - 'soft quotas'		
Short Haul	12-13	
Long Haul	2-3	
Domestic	0	

Loughborough University / ABC Project - Job No: 5346

QUOTA SHEET - 14-16 Interviews

TERMINAL 2

Interviewer: ________________________ **Date: _____ / _____ / 2011**

Gender	Required	Achieved
Male	7-8	
Female	7-8	

Age spread		
Up to 34 years	5	
35-44	2-3	
45-64	6-7	
65+ years	1	

Purpose of trip		
Business	1-2	
Leisure	13-14	

Try to get a spread of destinations too - 'soft quotas'		
Short Haul	8-9	
Long Haul	6-7	
Domestic	0	

Loughborough University / ABC Project - Job No: 5346

QUOTA SHEET

TERMINAL 3 - 14-16 Interviews

Interviewer: ___________________________ **Date: _____ / _____ / 2011**

Gender	Required	Achieved
Male	7-8	
Female	7-8	

Age spread		
Up to 34 years	5	
35-44	2-3	
45-64	6-7	
65+ years	1	

Purpose of trip		
Business	5	
Leisure	9-11	

Try to get a spread of destinations too - 'soft quotas'		
Short Haul	7-8	
Long Haul	2-3	
Domestic	5	

Appendix D: Agglomeration schedules for cluster analysis procedures

Passengers with car access (*n=664)*

Agglomeration schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	305	310	.000	0	0	223
2	536	539	.263	0	0	391
3	626	628	.628	0	0	154
4	333	554	1.014	0	0	15
5	390	498	1.419	0	0	35
6	292	483	1.837	0	0	127
7	454	571	2.320	0	0	50
8	204	245	2.868	0	0	296
9	542	581	3.424	0	0	262
10	3	4	4.005	0	0	152
11	537	546	4.629	0	0	31
12	436	564	5.270	0	0	191
13	137	148	5.927	0	0	154
14	312	442	6.635	0	0	169
15	333	497	7.368	4	0	41
16	9	172	8.118	0	0	428
17	369	594	8.880	0	0	42
18	13	259	9.655	0	0	253
19	142	243	10.455	0	0	128
20	301	394	11.275	0	0	50
21	227	647	12.096	0	0	417
22	242	251	12.930	0	0	174
23	291	565	13.807	0	0	326
24	297	372	14.701	0	0	302
25	540	657	15.595	0	0	57
26	132	215	16.492	0	0	54
27	67	76	17.406	0	0	172
28	213	258	18.323	0	0	162
29	323	591	19.240	0	0	294
30	318	641	20.160	0	0	343
31	537	655	21.082	11	0	131
32	607	635	22.010	0	0	158
33	336	416	22.942	0	0	276

34	523	660	23.878	0	0	293
35	390	637	24.820	5	0	318
36	439	466	25.765	0	0	310
37	371	477	26.726	0	0	42
38	502	638	27.689	0	0	213
39	574	604	28.677	0	0	459
40	149	240	29.673	0	0	401
41	333	615	30.670	15	0	129
42	369	371	31.681	17	37	109
43	361	578	32.694	0	0	295
44	41	202	33.713	0	0	296
45	491	622	34.739	0	0	74
46	480	559	35.768	0	0	232
47	189	283	36.810	0	0	539
48	519	630	37.856	0	0	234
49	424	511	38.907	0	0	310
50	301	454	39.962	20	7	370
51	337	640	41.019	0	0	93
52	568	587	42.099	0	0	79
53	175	445	43.202	0	0	354
54	69	132	44.322	0	26	422
55	435	623	45.467	0	0	467
56	366	533	46.619	0	0	218
57	538	540	47.775	0	25	309
58	313	437	48.937	0	0	160
59	232	458	50.104	0	0	165
60	229	230	51.279	0	0	156
61	92	143	52.461	0	0	375
62	271	575	53.651	0	0	285
63	389	662	54.845	0	0	212
64	121	208	56.051	0	0	145
65	470	653	57.258	0	0	92
66	606	648	58.484	0	0	175
67	621	642	59.716	0	0	249
68	179	216	60.980	0	0	393
69	407	421	62.245	0	0	278
70	473	651	63.526	0	0	294
71	118	128	64.809	0	0	178
72	228	658	66.107	0	0	116
73	474	603	67.404	0	0	177
74	491	656	68.723	45	0	425
75	307	534	70.045	0	0	282
76	549	580	71.382	0	0	232

77	420	488	72.725	0	0	146
78	286	342	74.075	0	0	275
79	248	568	75.448	0	52	368
80	358	598	76.823	0	0	97
81	169	412	78.200	0	0	246
82	501	545	79.588	0	0	334
83	513	659	80.977	0	0	289
84	505	552	82.368	0	0	345
85	364	579	83.770	0	0	278
86	45	273	85.174	0	0	519
87	5	127	86.589	0	0	468
88	314	515	88.007	0	0	375
89	174	188	89.428	0	0	271
90	64	84	90.858	0	0	173
91	98	311	92.293	0	0	323
92	470	610	93.732	65	0	181
93	337	629	95.175	51	0	123
94	452	590	96.662	0	0	293
95	440	631	98.164	0	0	376
96	326	530	99.684	0	0	262
97	125	358	101.208	0	80	221
98	338	401	102.734	0	0	276
99	331	507	104.260	0	0	269
100	113	644	105.796	0	0	356
101	109	400	107.347	0	0	334
102	588	605	108.907	0	0	449
103	201	557	110.468	0	0	258
104	548	649	112.034	0	0	473
105	386	664	113.605	0	0	320
106	131	328	115.177	0	0	253
107	324	620	116.752	0	0	424
108	478	650	118.343	0	0	413
109	369	592	119.935	42	0	219
110	417	453	121.529	0	0	367
111	79	322	123.134	0	0	150
112	83	181	124.739	0	0	271
113	104	316	126.357	0	0	340
114	71	182	127.978	0	0	439
115	419	654	129.605	0	0	370
116	228	450	131.231	72	0	318
117	165	524	132.859	0	0	341
118	78	91	134.490	0	0	145
119	72	340	136.132	0	0	181

120	87	415	137.785	0	0	159
121	81	166	139.462	0	0	384
122	61	270	141.143	0	0	281
123	337	422	142.824	93	0	352
124	89	325	144.505	0	0	317
125	66	159	146.187	0	0	196
126	321	493	147.878	0	0	287
127	289	292	149.577	0	6	326
128	142	144	151.281	19	0	237
129	333	395	152.988	41	0	288
130	75	183	154.702	0	0	342
131	500	537	156.430	0	31	309
132	482	619	158.159	0	0	299
133	298	438	159.889	0	0	499
134	397	583	161.627	0	0	430
135	203	347	163.365	0	0	250
136	387	409	165.115	0	0	320
137	327	341	166.869	0	0	406
138	106	133	168.629	0	0	442
139	300	618	170.395	0	0	205
140	315	597	172.165	0	0	312
141	60	173	173.937	0	0	222
142	85	392	175.732	0	0	240
143	456	526	177.548	0	0	297
144	475	589	179.370	0	0	279
145	78	121	181.200	118	64	231
146	44	420	183.030	0	77	388
147	368	378	184.861	0	0	248
148	107	370	186.694	0	0	340
149	147	168	188.533	0	0	231
150	79	108	190.375	111	0	496
151	290	567	192.237	0	0	352
152	3	112	194.111	10	0	410
153	350	582	195.991	0	0	301
154	137	626	197.876	13	3	258
155	198	365	199.775	0	0	218
156	52	229	201.691	0	60	395
157	185	563	203.618	0	0	265
158	404	607	205.547	0	32	417
159	87	299	207.485	120	0	305
160	313	332	209.431	58	0	388
161	433	569	211.380	0	0	396
162	15	213	213.336	0	28	363

163	101	484	215.297	0	0	333
164	192	193	217.259	0	0	308
165	199	232	219.229	0	59	526
166	352	614	221.199	0	0	224
167	346	602	223.192	0	0	408
168	426	427	225.188	0	0	371
169	43	312	227.202	0	14	292
170	485	486	229.222	0	0	513
171	38	206	231.244	0	0	255
172	67	74	233.275	27	0	409
173	64	256	235.322	90	0	489
174	177	242	237.369	0	22	445
175	375	606	239.420	0	66	339
176	376	384	241.491	0	0	225
177	434	474	243.582	0	73	330
178	118	462	245.694	71	0	338
179	282	431	247.807	0	0	359
180	516	599	249.923	0	0	379
181	72	470	252.041	119	92	431
182	304	617	254.165	0	0	298
183	522	543	256.290	0	0	324
184	287	382	258.437	0	0	381
185	468	627	260.587	0	0	532
186	272	279	262.743	0	0	345
187	356	449	264.906	0	0	397
188	59	260	267.071	0	0	347
189	105	276	269.240	0	0	419
190	58	459	271.414	0	0	464
191	432	436	273.592	0	12	365
192	295	633	275.770	0	0	403
193	23	37	277.950	0	0	270
194	383	555	280.132	0	0	392
195	77	217	282.331	0	0	387
196	26	66	284.543	0	125	505
197	46	266	286.772	0	0	444
198	388	529	289.007	0	0	411
199	51	141	291.246	0	0	479
200	319	351	293.489	0	0	450
201	343	514	295.733	0	0	508
202	25	254	297.978	0	0	236
203	34	167	300.231	0	0	453
204	119	577	302.490	0	0	435
205	300	353	304.766	139	0	406

206	22	233	307.043	0	0	389
207	111	238	309.332	0	0	454
208	374	461	311.628	0	0	483
209	457	556	313.929	0	0	472
210	63	190	316.246	0	0	477
211	155	158	318.569	0	0	389
212	389	408	320.894	63	0	298
213	367	502	323.232	0	38	418
214	86	191	325.581	0	0	426
215	97	239	327.930	0	0	427
216	296	492	330.287	0	0	396
217	62	294	332.644	0	0	353
218	198	366	335.023	155	56	367
219	369	663	337.408	109	0	557
220	506	643	339.798	0	0	478
221	125	499	342.191	97	0	471
222	60	207	344.588	141	0	405
223	305	558	346.989	1	0	350
224	352	423	349.396	166	0	503
225	376	593	351.811	176	0	357
226	405	528	354.231	0	0	399
227	160	661	356.654	0	0	362
228	80	244	359.091	0	0	381
229	70	219	361.537	0	0	509
230	385	521	363.985	0	0	491
231	78	147	366.434	145	149	393
232	480	549	368.887	46	76	483
233	1	21	371.339	0	0	446
234	519	566	373.794	48	0	481
235	54	197	376.251	0	0	456
236	25	49	378.712	202	0	527
237	33	142	381.175	0	128	286
238	120	357	383.648	0	0	333
239	93	138	386.123	0	0	553
240	85	100	388.622	142	0	430
241	153	164	391.123	0	0	423
242	135	451	393.628	0	0	429
243	6	88	396.151	0	0	405
244	73	157	398.677	0	0	421
245	162	220	401.228	0	0	533
246	169	235	403.783	81	0	315
247	495	636	406.348	0	0	475
248	47	368	408.925	0	147	364

249	330	621	411.509	0	67	343
250	203	496	414.106	135	0	491
251	126	494	416.729	0	0	376
252	345	608	419.353	0	0	351
253	13	131	421.988	18	106	409
254	348	572	424.625	0	0	397
255	18	38	427.267	0	171	458
256	379	503	429.910	0	0	382
257	114	280	432.555	0	0	353
258	137	201	435.224	154	103	506
259	27	339	437.908	0	0	534
260	209	576	440.613	0	0	440
261	156	255	443.327	0	0	451
262	326	542	446.041	96	9	461
263	509	547	448.764	0	0	348
264	309	402	451.497	0	0	443
265	185	471	454.238	157	0	297
266	56	448	456.987	0	0	515
267	117	520	459.761	0	0	546
268	443	624	462.545	0	0	436
269	331	363	465.352	99	0	484
270	23	129	468.160	193	0	518
271	83	174	470.974	112	89	450
272	277	302	473.795	0	0	439
273	320	411	476.620	0	0	415
274	36	68	479.458	0	0	401
275	286	334	482.314	78	0	528
276	336	338	485.176	33	98	490
277	225	359	488.056	0	0	547
278	364	407	490.949	85	69	496
279	475	585	493.852	144	0	502
280	267	532	496.772	0	0	499
281	61	211	499.696	122	0	466
282	307	639	502.642	75	0	366
283	262	284	505.621	0	0	527
284	455	465	508.611	0	0	486
285	265	271	511.605	0	62	395
286	33	306	514.614	237	0	536
287	152	321	517.631	0	126	471
288	333	562	520.661	129	0	476
289	467	513	523.695	0	83	394
290	30	200	526.732	0	0	441
291	218	535	529.777	0	0	407

292	8	43	532.837	0	169	514
293	452	523	535.914	94	34	365
294	323	473	539.006	29	70	469
295	361	600	542.106	43	0	446
296	41	204	545.208	44	8	410
297	185	456	548.316	265	143	524
298	304	389	551.427	182	212	391
299	482	525	554.542	132	0	418
300	241	413	557.661	0	0	541
301	350	354	560.782	153	0	494
302	57	297	563.908	0	24	444
303	39	42	567.037	0	0	404
304	355	373	570.175	0	0	419
305	87	123	573.317	159	0	445
306	10	180	576.460	0	0	517
307	116	425	579.603	0	0	516
308	192	285	582.784	164	0	373
309	500	538	586.004	131	57	469
310	424	439	589.255	49	36	512
311	65	176	592.508	0	0	420
312	315	479	595.766	140	0	451
313	595	616	599.036	0	0	555
314	308	517	602.308	0	0	507
315	169	652	605.631	246	0	525
316	29	263	608.957	0	0	475
317	89	145	612.292	124	0	549
318	228	390	615.634	116	35	488
319	24	418	618.977	0	0	513
320	386	387	622.322	105	136	594
321	12	96	625.673	0	0	492
322	490	584	629.031	0	0	440
323	98	130	632.395	91	0	363
324	522	613	635.759	183	0	477
325	396	612	639.139	0	0	448
326	289	291	642.520	127	23	558
327	102	381	645.932	0	0	455
328	40	463	649.352	0	0	482
329	250	380	652.812	0	0	500
330	434	510	656.287	177	0	565
331	406	527	659.774	0	0	515
332	16	281	663.266	0	0	535
333	101	120	666.775	163	238	458
334	109	501	670.291	101	82	350

335	210	221	673.809	0	0	412
336	293	518	677.334	0	0	460
337	234	560	680.867	0	0	360
338	118	223	684.403	178	0	466
339	375	377	687.942	175	0	524
340	104	107	691.501	113	148	522
341	165	222	695.071	117	0	362
342	14	75	698.652	0	130	398
343	318	330	702.246	30	249	422
344	53	586	705.849	0	0	498
345	272	505	709.464	186	84	502
346	429	512	713.093	0	0	435
347	59	186	716.731	188	0	416
348	481	509	720.383	0	263	424
349	150	249	724.042	0	0	438
350	109	305	727.714	334	223	591
351	344	345	731.390	0	252	521
352	290	337	735.068	151	123	486
353	62	114	738.769	217	257	436
354	170	175	742.471	0	53	426
355	17	596	746.174	0	0	463
356	113	268	749.885	100	0	487
357	31	376	753.610	0	225	512
358	19	253	757.340	0	0	521
359	35	282	761.080	0	179	434
360	234	570	764.830	337	0	494
361	184	214	768.586	0	0	530
362	160	165	772.356	227	341	497
363	15	98	776.136	162	323	510
364	47	487	779.937	248	0	425
365	432	452	783.743	191	293	544
366	307	508	787.561	282	0	485
367	198	417	791.417	218	110	533
368	171	248	795.275	0	79	489
369	212	360	799.152	0	0	498
370	301	419	803.064	50	115	413
371	426	573	806.990	168	0	447
372	154	446	810.928	0	0	590
373	139	192	814.946	0	308	455
374	134	329	818.975	0	0	470
375	92	314	823.008	61	88	437
376	126	440	827.047	251	95	461
377	103	237	831.110	0	0	437

378	231	531	835.177	0	0	472
379	444	516	839.302	0	180	532
380	335	472	843.427	0	0	567
381	80	287	847.567	228	184	531
382	261	379	851.711	0	256	416
383	246	303	855.864	0	0	480
384	81	441	860.017	121	0	586
385	224	541	864.194	0	0	500
386	20	196	868.400	0	0	468
387	77	551	872.649	195	0	490
388	44	313	876.905	146	160	481
389	22	155	881.197	206	211	479
390	94	476	885.491	0	0	433
391	304	536	889.839	298	2	558
392	383	544	894.192	194	0	431
393	78	179	898.545	231	68	474
394	399	467	902.921	0	289	561
395	52	265	907.302	156	285	537
396	296	433	911.711	216	161	476
397	348	356	916.169	254	187	449
398	14	489	920.628	342	0	606
399	257	405	925.124	0	226	503
400	288	428	929.635	0	0	573
401	36	149	934.147	274	40	474
402	275	349	938.697	0	0	548
403	295	611	943.282	192	0	497
404	39	178	947.876	303	0	568
405	6	60	952.499	243	222	546
406	300	327	957.133	205	137	473
407	218	601	961.792	291	0	534
408	55	346	966.451	0	167	559
409	13	67	971.121	253	172	545
410	3	41	975.817	152	296	510
411	48	388	980.621	0	198	459
412	210	236	985.433	335	0	603
413	301	478	990.251	370	108	560
414	7	140	995.111	0	0	511
415	252	320	1000.020	0	273	557
416	59	261	1004.967	347	382	488
417	227	404	1009.916	21	158	544
418	367	482	1014.887	213	299	519
419	105	355	1019.873	189	304	529
420	65	226	1024.867	311	0	501

421	73	146	1029.869	244	0	441
422	69	318	1034.877	54	343	575
423	2	153	1039.903	0	241	463
424	324	481	1044.929	107	348	542
425	47	491	1049.957	364	74	550
426	86	170	1054.987	214	354	554
427	97	163	1060.037	215	0	574
428	9	205	1065.115	16	0	509
429	135	464	1070.208	242	0	492
430	85	397	1075.338	240	134	543
431	72	383	1080.490	181	392	467
432	194	561	1085.694	0	0	493
433	94	247	1090.951	390	0	576
434	35	95	1096.215	359	0	584
435	119	429	1101.484	204	346	553
436	62	443	1106.755	353	268	448
437	92	103	1112.052	375	377	462
438	150	430	1117.365	349	0	538
439	71	277	1122.699	114	272	465
440	209	490	1128.077	260	322	579
441	30	73	1133.468	290	421	582
442	106	269	1138.918	138	0	511
443	110	309	1144.371	0	264	639
444	46	57	1149.864	197	302	551
445	87	177	1155.360	305	174	528
446	1	361	1160.897	233	295	570
447	426	609	1166.468	371	0	535
448	62	396	1172.066	436	325	607
449	348	588	1177.674	397	102	508
450	83	319	1183.367	271	200	537
451	156	315	1189.070	261	312	543
452	28	264	1194.809	0	0	529
453	34	410	1200.560	203	0	566
454	90	111	1206.318	0	207	566
455	102	139	1212.145	327	373	585
456	54	504	1218.023	235	0	520
457	115	151	1223.916	0	0	578
458	18	101	1229.815	255	333	604
459	48	574	1235.771	411	39	612
460	293	414	1241.773	336	0	517
461	126	326	1247.800	376	262	575
462	92	460	1253.923	437	0	478
463	2	17	1260.079	423	355	584

464	58	625	1266.246	190	0	572
465	71	124	1272.446	439	0	507
466	61	118	1278.682	281	338	569
467	72	435	1284.989	431	55	587
468	5	20	1291.349	87	386	577
469	323	500	1297.754	294	309	560
470	82	134	1304.266	0	374	603
471	125	152	1310.807	221	287	522
472	231	457	1317.359	378	209	551
473	300	548	1323.954	406	104	547
474	36	78	1330.558	401	393	595
475	29	495	1337.189	316	247	541
476	296	333	1343.885	396	288	564
477	63	522	1350.646	210	324	545
478	92	506	1357.411	462	220	565
479	22	51	1364.200	389	199	589
480	11	246	1371.005	0	383	531
481	44	519	1377.862	388	234	564
482	40	50	1384.742	328	0	516
483	374	480	1391.640	208	232	595
484	331	391	1398.576	269	0	539
485	307	447	1405.527	366	0	582
486	290	455	1412.567	352	284	514
487	113	398	1419.705	356	0	581
488	59	228	1426.857	416	318	581
489	64	171	1434.011	173	368	552
490	77	336	1441.177	387	276	530
491	203	385	1448.415	250	230	585
492	12	135	1455.656	321	429	586
493	194	278	1462.903	432	0	597
494	234	350	1470.166	360	301	561
495	274	553	1477.472	0	0	577
496	79	364	1484.854	150	278	554
497	160	295	1492.280	362	403	525
498	53	212	1499.747	344	369	571
499	267	298	1507.223	280	133	526
500	224	250	1514.784	385	329	542
501	65	634	1522.360	420	0	556
502	272	475	1529.961	345	279	587
503	257	352	1537.649	399	224	562
504	122	362	1545.353	0	0	563
505	26	161	1553.134	196	0	552
506	136	137	1560.920	0	258	602

507	71	308	1568.718	465	314	589
508	343	348	1576.598	201	449	592
509	9	70	1584.539	428	229	601
510	3	15	1592.529	410	363	594
511	7	106	1600.563	414	442	548
512	31	424	1608.610	357	310	600
513	24	485	1616.698	319	170	556
514	8	290	1624.876	292	486	615
515	56	406	1633.086	266	331	607
516	40	116	1641.300	482	307	579
517	10	293	1649.654	306	460	628
518	23	469	1658.218	270	0	538
519	45	367	1666.905	86	418	550
520	54	187	1675.595	456	0	618
521	19	344	1684.366	358	351	621
522	104	125	1693.143	340	471	583
523	393	632	1701.978	0	0	563
524	185	375	1710.857	297	339	598
525	160	169	1719.917	497	315	611
526	199	267	1729.031	165	499	572
527	25	262	1738.204	236	283	610
528	87	286	1747.399	445	275	570
529	28	105	1756.661	452	419	578
530	77	184	1766.015	490	361	605
531	11	80	1775.385	480	381	596
532	444	468	1784.801	379	185	559
533	162	198	1794.241	245	367	555
534	27	218	1803.706	259	407	574
535	16	426	1813.189	332	447	573
536	33	317	1822.694	286	0	571
537	52	83	1832.230	395	450	549
538	23	150	1841.864	518	438	617
539	189	331	1851.535	47	484	576
540	32	99	1861.306	0	0	596
541	29	241	1871.263	475	300	597
542	224	324	1881.288	500	424	590
543	85	156	1891.334	430	451	568
544	227	432	1901.496	417	365	591
545	13	63	1911.906	409	477	569
546	6	117	1922.343	405	267	608
547	225	300	1932.903	277	473	598
548	7	275	1943.518	511	402	567
549	52	89	1954.442	537	317	616

550	45	47	1965.391	519	425	602
551	46	231	1976.417	444	472	624
552	26	64	1987.560	505	489	593
553	93	119	1998.776	239	435	611
554	79	86	2010.075	496	426	600
555	162	595	2021.463	533	313	593
556	24	65	2033.133	513	501	599
557	252	369	2044.941	415	219	580
558	289	304	2056.767	326	391	609
559	55	444	2068.713	408	532	630
560	301	323	2080.664	413	469	583
561	234	399	2092.646	494	394	604
562	195	257	2104.690	0	503	638
563	122	393	2116.844	504	523	613
564	44	296	2129.381	481	476	605
565	92	434	2141.956	478	330	623
566	34	90	2154.619	453	454	599
567	7	335	2167.303	548	380	608
568	39	85	2180.568	404	543	615
569	13	61	2193.867	545	466	616
570	1	87	2207.344	446	528	601
571	33	53	2220.867	536	498	626
572	58	199	2234.518	464	526	619
573	16	288	2248.825	535	400	629
574	27	97	2263.172	534	427	625
575	69	126	2277.541	422	461	623
576	94	189	2292.018	433	539	622
577	5	274	2306.500	468	495	632
578	28	115	2321.045	529	457	636
579	40	209	2335.914	516	440	637
580	252	550	2350.859	557	0	612
581	59	113	2366.131	488	487	609
582	30	307	2381.481	441	485	640
583	104	301	2396.901	522	560	620
584	2	35	2412.413	463	434	613
585	102	203	2428.002	455	491	627
586	12	81	2444.240	492	384	644
587	72	272	2460.722	467	502	619
588	403	645	2477.244	0	0	622
589	22	71	2493.847	479	507	630
590	154	224	2510.642	372	542	629
591	109	227	2527.627	350	544	626
592	343	646	2544.751	508	0	614

593	26	162	2562.339	552	555	614
594	3	386	2579.991	510	320	634
595	36	374	2597.825	474	483	627
596	11	32	2615.747	531	540	651
597	29	194	2634.021	541	493	617
598	185	225	2652.377	524	547	628
599	24	34	2670.775	556	566	618
600	31	79	2689.987	512	554	606
601	1	9	2709.389	570	509	625
602	45	136	2728.910	550	506	635
603	82	210	2748.481	470	412	621
604	18	234	2768.824	458	561	610
605	44	77	2789.295	564	530	647
606	14	31	2809.802	398	600	634
607	56	62	2830.486	515	448	624
608	6	7	2851.921	546	567	652
609	59	289	2874.004	581	558	645
610	18	25	2896.751	604	527	638
611	93	160	2919.735	553	525	631
612	48	252	2943.069	459	580	620
613	2	122	2968.126	584	563	650
614	26	343	2993.877	593	592	643
615	8	39	3021.134	514	568	633
616	13	52	3048.423	569	549	642
617	23	29	3076.131	538	597	648
618	24	54	3104.102	599	520	632
619	58	72	3133.485	572	587	641
620	48	104	3163.270	612	583	642
621	19	82	3194.564	521	603	633
622	94	403	3225.953	576	588	640
623	69	92	3257.512	575	565	649
624	46	56	3289.830	551	607	644
625	1	27	3322.203	601	574	631
626	33	109	3354.790	571	591	635
627	36	102	3387.812	595	585	647
628	10	185	3422.553	517	598	636
629	16	154	3457.901	573	590	646
630	22	55	3494.437	589	559	637
631	1	93	3532.318	625	611	654
632	5	24	3571.890	577	618	639
633	8	19	3612.760	615	621	643
634	3	14	3654.371	594	606	641
635	33	45	3700.312	626	602	653

636	10	28	3746.990	628	578	645
637	22	40	3793.883	630	579	648
638	18	195	3843.417	610	562	646
639	5	110	3893.048	632	443	656
640	30	94	3942.744	582	622	653
641	3	58	3992.490	634	619	657
642	13	48	4042.726	616	620	658
643	8	26	4097.073	633	614	661
644	12	46	4155.177	586	624	651
645	10	59	4224.982	636	609	650
646	16	18	4296.379	629	638	652
647	36	44	4369.932	627	605	649
648	22	23	4444.762	637	617	656
649	36	69	4521.484	647	623	657
650	2	10	4599.564	613	645	654
651	11	12	4678.496	596	644	655
652	6	16	4762.876	608	646	660
653	30	33	4866.059	640	635	655
654	1	2	4987.651	631	650	662
655	11	30	5121.155	651	653	658
656	5	22	5261.015	639	648	660
657	3	36	5426.917	641	649	659
658	11	13	5613.754	655	642	659
659	3	11	5823.435	657	658	661
660	5	6	6056.410	656	652	662
661	3	8	6300.903	659	643	663
662	1	5	6626.106	654	660	663
663	1	3	7305.541	662	661	0

Passengers without car access (*n=184)*

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	42	118	.366	0	0	80
2	57	67	.812	0	0	10
3	82	146	1.285	0	0	12
4	154	184	1.807	0	0	36
5	3	101	2.333	0	0	85
6	168	171	3.149	0	0	61
7	69	76	4.089	0	0	43
8	89	117	5.029	0	0	110
9	152	182	5.993	0	0	97
10	57	124	7.024	2	0	60
11	24	52	8.058	0	0	43
12	82	145	9.092	3	0	106
13	11	13	10.168	0	0	99
14	36	59	11.253	0	0	96
15	83	134	12.367	0	0	98
16	45	63	13.482	0	0	92
17	84	151	14.630	0	0	72
18	19	109	15.795	0	0	50
19	112	179	16.967	0	0	92
20	44	47	18.171	0	0	49
21	106	121	19.416	0	0	38
22	92	160	20.677	0	0	106
23	25	131	21.962	0	0	71
24	1	33	23.255	0	0	46
25	60	174	24.574	0	0	87
26	86	132	25.905	0	0	63
27	75	120	27.250	0	0	56
28	107	161	28.620	0	0	100
29	5	105	29.993	0	0	74
30	31	51	31.396	0	0	69
31	159	163	32.833	0	0	95
32	40	123	34.321	0	0	138
33	93	129	35.836	0	0	72
34	54	65	37.479	0	0	87
35	12	78	39.168	0	0	48
36	154	175	40.891	4	0	84
37	100	180	42.648	0	0	108
38	106	170	44.411	21	0	67

39	34	142	46.189	0	0	105
40	97	115	47.991	0	0	131
41	18	46	49.820	0	0	76
42	17	87	51.669	0	0	77
43	24	69	53.524	11	7	88
44	122	127	55.391	0	0	89
45	10	116	57.302	0	0	57
46	1	72	59.219	24	0	68
47	6	9	61.161	0	0	80
48	12	166	63.104	35	0	86
49	44	62	65.050	20	0	125
50	19	139	67.028	18	0	105
51	113	130	69.006	0	0	101
52	73	114	71.050	0	0	81
53	29	49	73.096	0	0	137
54	81	140	75.165	0	0	93
55	95	156	77.245	0	0	128
56	75	96	79.395	27	0	104
57	10	43	81.588	45	0	136
58	2	7	83.814	0	0	112
59	30	98	86.045	0	0	124
60	57	149	88.354	10	0	109
61	158	168	90.686	0	6	158
62	74	150	93.022	0	0	86
63	86	90	95.367	26	0	88
64	68	103	97.726	0	0	82
65	14	20	100.092	0	0	121
66	141	153	102.545	0	0	109
67	106	164	105.021	38	0	134
68	1	15	107.509	46	0	149
69	31	181	110.042	30	0	119
70	26	144	112.617	0	0	101
71	25	111	115.238	23	0	136
72	84	93	117.977	17	33	118
73	8	136	120.748	0	0	114
74	5	104	123.538	29	0	125
75	41	58	126.348	0	0	137
76	18	143	129.179	41	0	128
77	17	53	132.020	42	0	117
78	32	183	134.878	0	0	122
79	64	126	137.750	0	0	114
80	6	42	140.643	47	1	121
81	50	73	143.537	0	52	117

82	68	148	146.434	64	0	139
83	77	173	149.348	0	0	150
84	61	154	152.287	0	36	120
85	3	35	155.229	5	0	140
86	12	74	158.183	48	62	115
87	54	60	161.175	34	25	120
88	24	86	164.199	43	63	159
89	108	122	167.247	0	44	110
90	70	71	170.369	0	0	148
91	56	99	173.557	0	0	107
92	45	112	176.792	16	19	100
93	79	81	180.065	0	54	134
94	91	128	183.363	0	0	102
95	37	159	186.817	0	31	145
96	21	36	190.388	0	14	143
97	4	152	193.962	0	9	150
98	83	167	197.548	15	0	145
99	11	85	201.134	13	0	129
100	45	107	204.856	92	28	116
101	26	113	208.695	70	51	126
102	16	91	212.563	0	94	140
103	119	162	216.455	0	0	124
104	38	75	220.353	0	56	118
105	19	34	224.271	50	39	148
106	82	92	228.198	12	22	131
107	56	155	232.313	91	0	138
108	100	172	236.471	37	0	141
109	57	141	240.683	60	66	143
110	89	108	244.939	8	89	139
111	28	55	249.384	0	0	135
112	2	23	253.985	58	0	127
113	125	157	258.587	0	0	144
114	8	64	263.458	73	79	154
115	12	138	268.370	86	0	157
116	45	137	273.291	100	0	123
117	17	50	278.387	77	81	149
118	38	84	283.497	104	72	147
119	31	176	288.741	69	0	141
120	54	61	294.085	87	84	168
121	6	14	299.472	80	65	169
122	32	147	304.954	78	0	153
123	45	178	310.494	116	0	142
124	30	119	316.050	59	103	151

125	5	44	321.852	74	49	152
126	26	94	327.695	101	0	156
127	2	66	333.549	112	0	153
128	18	95	339.482	76	55	157
129	11	133	345.466	99	0	162
130	80	88	351.560	0	0	170
131	82	97	357.844	106	40	147
132	22	169	364.382	0	0	161
133	39	110	371.255	0	0	174
134	79	106	378.258	93	67	162
135	28	177	385.272	111	0	164
136	10	25	392.354	57	71	160
137	29	41	399.771	53	75	155
138	40	56	407.234	32	107	154
139	68	89	415.062	82	110	152
140	3	16	422.957	85	102	156
141	31	100	430.963	119	108	163
142	45	165	439.394	123	0	158
143	21	57	447.836	96	109	160
144	125	135	456.304	113	0	166
145	37	83	464.809	95	98	146
146	27	37	473.630	0	145	163
147	38	82	482.476	118	131	165
148	19	70	491.595	105	90	159
149	1	17	500.927	68	117	161
150	4	77	510.261	97	83	166
151	30	102	520.002	124	0	172
152	5	68	530.141	125	139	168
153	2	32	540.595	127	122	165
154	8	40	551.140	114	138	174
155	29	48	562.409	137	0	167
156	3	26	573.791	140	126	171
157	12	18	585.748	115	128	170
158	45	158	598.572	142	61	177
159	19	24	611.583	148	88	164
160	10	21	624.811	136	143	169
161	1	22	638.767	149	132	175
162	11	79	653.438	129	134	167
163	27	31	668.803	146	141	173
164	19	28	684.594	159	135	171
165	2	38	702.464	153	147	179
166	4	125	720.504	150	144	176
167	11	29	740.502	162	155	176

168	5	54	760.684	152	120	173
169	6	10	782.960	121	160	172
170	12	80	810.068	157	130	180
171	3	19	837.317	156	164	175
172	6	30	866.733	169	151	178
173	5	27	897.931	168	163	177
174	8	39	930.570	154	133	178
175	1	3	963.496	161	171	182
176	4	11	999.906	166	167	181
177	5	45	1039.635	173	158	180
178	6	8	1083.067	172	174	179
179	2	6	1140.793	165	178	182
180	5	12	1202.650	177	170	181
181	4	5	1276.764	176	180	183
182	1	2	1387.439	175	179	183
183	1	4	1644.543	182	181	0

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