An exploration of the characteristics of excess travel within commuting

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Abstract

Travel behaviour research aims to inform and provide evidence for sound transport policy. Excess travel, where individuals demonstrate excessive use of for example time or distance, challenges assumptions underpinning fundamental beliefs of travel behaviour research where travel should be minimised in order to get to the destination. This thesis explores the phenomenon of excess travel and the characteristics of people exhibiting excess travel within a commuting context, using Tyne and Wear as a case study. Building on existing definitions of excess commuting, which include time and distance, this study gradually adds additional parameters of cost, effort, and many other parameters (e.g. value of time, weights for walking and waiting) in the generalised cost formula, and the final sample is analysed to identify similarities and differences between excess commuters (EC) and not excess commuters (NEC). The methodology uses a GIS technique for sampling and a questionnaire approach for data collection. The final sample includes origin-based (home) commuters who completed a questionnaire delivered to their home addresses, and destination-based (work) commuters who completed an online version of the same questionnaire.

Analytical methods are used to identify EC and NEC based on self-reported ('pure') values of the four key parameters of time, cost, distance and effort while commuting and using a generalised cost approach. For the parameters of time and cost as well as for the generalised cost results seven saving options are considered, where 5% savings is the lowest option and 50% or more savings is the highest option. An analysis of various attributes and their differences in medians together with a series of socio-economic characteristics are used to distinguish between EC and NEC within the four groups in total (time, cost, effort, generalised cost).

The results show that within the collected sample EC make up between 32% (in the cost group) and 78% (in the effort group) of the total sample (depending on the parameter/group considered), and that there are some statistically significant differences at the 95% level between EC and NEC within the groups. The fact that the number of EC varies between the groups is to be expected, as the literature review suggested that taking different parameters into account produces different results. Generally, EC seem to behave in a similar manner to the rest of the sample, in terms of most of the factors tested, when making choices about commuting, but for example 41% of the respondents

drive to work and within this driving group there are more EC than NEC (for example 44% of EC versus 37% of NEC within the time group or 52% of EC versus 36% of NEC within the cost group). More importantly, the median values for the four key parameters of travel to work (actual commute time, ideal one-way commute time, commute cost, commute distance) are higher in majority of the cases for EC than for NEC within the four groups. Attitudes and preferences also play a role, demonstrating that the most frequent trip purpose, the commute, can provide some benefit to travellers. The results also show that in terms of the activities such as listening to music/radio, reading book/newspapers, exercising or concentrating on the road a majority of statistically significant differences between EC and NEC occur within the cost and the effort groups only. The demand for more direct routes and cheaper fares on public transport is emphasised by the majority of the sample. The respondents tend to be well informed about their travel to work alternative transport modes and different transport planning tools available, and the Internet stands out as a primary source of information employed by majority of both EC and NEC. In exploring the characteristics of EC and NEC in more depth, recommendations are identified for public transport providers to improve their services and encourage more commuters to transfer travel time into activity time.

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When I started my PhD I was introduced to the motto: “It is about the journey, not the destination”. My journey took me nearly 8 years (part-time) and it has been a wonderful, most challenging, hated and loved period in my life. I have spent a quarter of my life on the excess commuting research project and still feel I do not know much about the topic. But at least I know enough to earn a PhD title. Yes, it is about the journey, but I am extremely happy and grateful that I managed to reach the desired destination. Finally!

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Chapter 1. Introduction

1.1 Background

The way people make their travel choices is at the heart of our understanding of travel behaviour which is a core element in making transport policy decisions. The traditional approach has been underpinned by an assumption that individuals are motivated to travel in order to undertake activities at the destination and that the process of travelling itself does not give rise to any positive experience.

Over the last 30 years a number of authors, who focused on *"the difference between the actual mean commute and the minimised mean commute"* (Hamilton (1982, p. 1040)), contributed to the developments in the travel behaviour literature. The phenomenon they have highlighted is referred to as the "excess travel" (or excess commuting) in the literature. A number of issues have been highlighted in the context of excess commuting, with the three main focusing on contextual, methodological and policy-related issues. However, the literature also suggests that individuals achieving benefit from the travel process may travel more than those who meet the traditional assumptions of only travelling so as to reach a destination. This phenomenon has been attracting more attention in the transport research community over the last decade (Mokhtarian, 2001) and new definitions of excess travel, taking into account for example satisfaction level, have been suggested. An example of such a definition is the definition by Salomon and Mokhtarian (1998, p. 132) who suggested that: "*travel that exceeds what could be a minimum satisfying level*" should be called excess travel.

In focusing on the identification of excess commuting, studies have used many different definitions with results apparently varying according to whether the measurement benchmark focuses on the time spent travelling or the distance travelled. The wider literature of travel demand exposes other parameters of travel (e.g. monetary cost or physical effort) and soft factors (e.g. travel safety, enjoyment) as being important in the travel decision process. These factors may be especially important in the journey to work as a regular journey when it is more likely that they will be included in the minimisation of their 'travel budgets' (time, cost, effort etc.). This study, as with many previous studies on excess travel, focuses on travel to work. However, the motivation of this research is to understand the characteristics of excess travellers in order to advise public transport providers on how to attract passengers to travel more efficiently and in

a more environmentally friendly way by using public transport or by making travel more productive for example. A primary aim of this research is to better understand the nature of excess commute and the motives of travelling. Although one reason might be a commuter's positive utility of travel which distinguishes the characteristics of excess commuters (EC) from not excess commuters (NEC), the analyses also consider socio-economic conditions, perceptions of transport modes, attitudes towards travel and the individual's approach to travel planning. This study is therefore underpinned by a motivation to understand travel behaviour in more depth so as to contribute to the wider policy concerns of travel behaviour change.

The next section considers the UK context since this study uses a case study approach for investigation.

1.2 The UK context

In the UK, transport policy is a focus of central government as well as, at a more detailed level, local government. This section first addresses the central government context for travel before turning to the local context of Tyne and Wear which governs the geographical area in which the case study for this analysis is set.

In 2004 the Department for Transport published "The Future of Transport: A network for 2030" – the UK's long-term transport strategy. The document offered a comprehensive overview of the transport sector and aspirations for change. The strategy highlighted local travel enhancement through:

- *freer flowing local roads delivered though measures such as congestion charging;*
- *more, and more reliable buses enjoying more road space;*
- *demand responsive bus services that provide accessibility in areas that cannot support conventional services;*
- *looking at ways to make services more accessible so that people have a real choice about when and how they travel;*
- *promoting the use of school travel plans, workplace travel plans and personalised journey planning to encourage people to consider alternatives to using their cars;*
- *creating a culture and improved quality of local environment so that cycling and walking are seen as an attractive alternative to car travel for short journeys, particularly for children.*

DfT (2004, p. 15)

The government also recognised that commuters take advantage of good transport networks by "accepting longer commuting distances in exchange for other advantages, such as allowing their children to stay at the same school" (DfT, 2004, p. 21) and suggested that in the future "smarter individual choices" (DfT, 2004, p. 35) will need to be facilitated by offering alternatives to the car. More specifically, a clear message was expressed about the positive impact of workplace travel plans, individualised marketing and public transport information and marketing in the promotion of the smarter choices schemes.

Meanwhile, in Tyne and Wear, lessons from the Government's recommendations and local transport experiences have been translated into local policy. In 2011, the Tyne and Wear Integrated Transport Authority published a new Transport Plan Strategy for the county. The vision of travel change presented in this document was based on recognising the role of individual choice and need to provide more accessible travel information. The vision was:

> *"The Partners recognise that people have a free choice of where, when and how to travel and wish to provide a wider range of travel choices, with more easily accessible information on each option, to facilitate people's choices and promote the benefits of travel by more sustainable modes."*
>
> *Tyne and Wear Local Transport Plan 3 Strategy 2011-2021 (2011, p. 124)*

"Smarter choices" is a term that has been emerging in transport policy and is clearly defined as: "a series of measures and techniques which seek to encourage a change in travel behaviour, away from car use to others modes of travel amongst the target population" (TWITA, 2011, p. 130). The Tyne and Wear plan clearly focuses on smarter choices measures as well as personalised travel planning, parking policies and car club schemes. The Tyne and Wear strategy gives examples of successful transport schemes run in the area, for example Newcastle University cut the number of available car parking spaces and reduced the commute by car to 25% by providing infrastructure friendly to sustainable means of transport, whilst recognising more needs to be done to promote the sustainable travel options in the county.

Unsurprisingly, none of the above documents mention excess travel or excess commute phenomenon. This topic, to date, has been considered within the academic community

only. However, the motivation of this study is to expose the links between research on excess commuting behaviour and its benefits for public transport operators and transport policy-makers. The more people know about their travel options, the better decisions they can make to improve (minimise) it in terms of time, distance, cost and effort. Improving sustainable transport options through a better understanding of how to create an environment where the commute can give rise to a positive experience of travelling, will help to meet the wider objectives of transport policy in lowering CO_2 emissions, improving health and creating a safer environment. The aims and objectives of this study, described in the next section, are established to provide a sound understanding of the nature of excess travel behaviour within commuting and the identification of excess commuters so as to be able to draw conclusions and recommendations which will allow a drive to change commuting behaviour by individuals as well as public transport operators and policy makers.

1.3 Aims and objectives of the study

Within the context of recent developments in smarter choices strategies and the push for change in traveller (commuter) behaviour more generally, this study aims to explore the excess travel phenomenon. More specifically, the two main drivers of this study are to understand better the excess travel phenomenon within commuting by identifying EC and NEC and analysing their characteristics and to investigate the implications for the findings of the research in terms of advice for public transport operators by assessing commuters' readiness, or willingness, for change in their commute habits.

This study contributes to the wider picture of excess commuting by placing its research objectives around the five following areas. First, a critical review of the existing literature on excess commuting is needed to be able to identify clear research gaps. Secondly, the critical review should offer a baseline for identifying an appropriate methodology for EC identification. Thirdly, if EC can be distinguished from NEC, then their characteristics in terms of, for example, socio-economics, travel choices and attitudes towards commuting, can be examined. Fourthly, this study can contribute to knowledge by testing new methods, evaluating new results as well as providing an opportunity for comparison with earlier studies presented in the literature. Finally, the analysis of commuters' travel behaviour can provide valid information to public transport operators about the perception of their services by commuters and areas that require improvements. This leads to the five objectives of this study, which are:

Objective 1: *to conduct a literature review focused on excess commuting phenomenon and identify research gaps.*

Objective 2: to *design, develop and implement travel behaviour survey in appropriate case study areas in order to collect individual data on travel choices and identify potential for excess commuting behaviour.*

Objective 3: *To examine the excess commuting phenomenon within the sample collected to understand the drivers of excess commuting.*

Objective 4: *To discuss the results obtained in the context of the contribution to the existing literature and transport policy, particularly what this study has shown for public transport operators.*

Objective 5: *to investigate the implications for the findings of the research in terms of contribution to the current knowledge of excess commuting phenomenon*.

1.4 Structure of the thesis

This thesis has been divided into six chapters presenting the research journey undertaken in this study. Chapter 2 presents a critical review of literature on excess commuting in order to give the basic understanding of the phenomenon, issues considered so far and methods for excess commuting calculations. As a result of the review four research gaps are identified within this topic, which will be addressed by this study. Chapter 3 focuses on the methodology used in the study, including the questionnaire design and sampling methods. This then leads into two hypotheses, which shape the framework of the remaining body of the thesis. Chapter 4 explores the characteristics of excess travellers through a detailed analysis of the two hypotheses of this study. A discussion of the results in the context of the five objectives, presented above in Section 1.3, and the main points emerging from the study are presented in Chapter 5 Discussion and Evaluation. Based on the analysis, this chapter also offers advice for public transport operators relating to improvements they could implement to promote their services to commuters. The final chapter, Chapter 6, summarises conclusions from the study, highlights the contribution to knowledge, admits limitations of the study and recommends avenues for further research.

Chapter 2. Critical review of literature on the excess travel phenomenon

2.1 Introduction

The aim of this chapter is to critically review the available literature on excess travel to understand better how people make travel choices. This is important as the more we know about the way people make their decisions related to current day travel and the more we understand them, the more effectively we can influence their future travel choices (King and Inderwildi, 2010; Cairns *et. al.*, 2004). This understanding can help to influence transport policy makers and encourage individuals to reduce travel and maximise the utility of their future travel choices (e.g. in terms of benefits they get from travel and travel time use) to make the travel more sustainable (Cairns *et al.*, 2004; Malayath and Verma, 2013).

This chapter compares and contrasts traditional as well as a more recent approaches to the study of excess travel. In order to investigate these issues the particular focus of the chapter is on various factors influencing excess commuting (definitions of 'excess travel' are given below in Sections 2.3 and 2.4), as commuting is perceived as the most regular (in terms of time, distance and occurrence; Charron, 2007) and structured (in terms of origin-destination) of the journeys made by an individual. Commuting can also be part of a more complicated daily travel chain, which includes shopping trips, escorting children to school or giving a lift to the second worker in the household. According to the National Travel Survey 2011 (Department for Transport, 2012) in Great Britain commuting trips tended to be longer than average trips (4.4 miles in 2011) and accounted for 19% of the average distance travelled in 2011, the same as social visits to friends and slightly less than journeys made for other leisure purposes (22%). These commuting journeys contribute to peak congestion affecting cities (Horner and O'Kelly, 2007).

Moreover, it has been shown that job selection (location) often precedes residential selections (locations) (Fan *et al.*, 2011) whereas shopping or leisure locations rarely influence housing locations (Ben Akiva *et al.*, 1978). Therefore the amount of commuting has a role to play in residential-employment location decisions (Horner, 2002) and influences the spatial balance between locations (Suzuki and Lee, 2012). All

these reasons have attracted excess travel research within commuting, as an important and interesting topic studied across the world.

This chapter builds on the framework of the excess commuting review by Ma and Banister (2006) and includes up-to-date examples of various approaches to the excess commuting phenomenon presented in the literature, with the three main groups of factors (physical, social and psychological) discussed in more detail. The chapter is divided into six sections. Section 2.2 describes the evolution of the travel behaviour literature with emphasis on the shift from the theory of derived demand to the positive utility of travel. In Section 2.3 two approaches to excess commuting are explored, a monocentric model and a linear programming approach, with their definitions and measures used to quantify excess commuting. Section 2.4 investigates excess commuting in the light of methodological (Section 2.4.1), contextual (Section 2.4.2) and policy-related issues (2.4.3). Section 2.5 presents research gaps identified in the literature review and proposes ways of investigating the topic of excess commuting further in the thesis. The final section, Section 2.6 presents the key conclusions from the literature reviewed in the chapter.

2.2 The evolution of the travel behaviour literature

A general overview of travel behaviour literature is presented first before heading into detail on excess commuting. This material is important with respect to this research as it shows the shift of the perspective on travel behaviour from the theory of derived demand, which treated travel as a 'burden', to the positive utility of travel, where benefits derived from the act of travel were recognised and valued. In the context of the excess commuting literature a similar conceptual evolution took place, from a jobs-housing focused perspective to psychological perspective where reasons behind excess travel behaviour matter.

Urban travel is a complicated behavioural process (Dalvi, 1978) including decisions on and interactions between humans and systems, e.g. residential location, transport mode, travel route to work. Ben-Akiva *et al.* (1976) proposed two types of travel decision choices: long-run (long-term) and short-run (short-term) mobility. Long-term mobility choices are influenced by a long-term vision of an individual's mobility needs, and are related to decisions of house location, car ownership and mode of travel to work (Ben-Akiva *et al.*, 1976). Short-term travel choices, which may be more flexible, are linked to

trip frequency, route and time of the day for non-work trips (Ben-Akiva *et al.*, 1976). Long-term mobility choices are about planning ahead (e.g. home location) and influence the availability of short-run choice options (e.g. public transport modes available in the area). This distinction is important as it shows that there is a relationship between the two types of travel decisions, suggesting that short-run mobility is dependent on long-run mobility decisions (Ben-Akiva *et al.*, 1976).

In order to examine this complex relationship between different travel choices the transport literature has developed various economic theories of travel choice (e.g. travel as a derived demand). Traditionally travel choice theories were based on an assumption that trips are not taken for their own sake (Oi and Shuldiner, 1972; Richards and Ben-Akiva, 1975; Button, 1993) and as a consequence travel itself (meaning the act of moving from one place to another) does not improve human welfare (Dalvi, 1978). In other words travel is undertaken to 'consume' activities (e.g. leisure, shopping, work) at a destination (Cascetta, 2009; Cole, 1998). This approach highlighted that getting to the destination is the most important benefit obtained from travel and travel itself was perceived as a derived demand (Richmond and Ben-Akiva, 1975; Dalvi, 1978; Button, 1993; Powell, 2001; Jara-Diaz, 2007).

As travel was seen as a derived demand it was assumed that people follow the utility maximisation rule, where they rate their travel alternatives and decide on the option which offers the greatest net utility (Recker, 2001). This concept assumes that travel has a negative utility and that travellers are cost minimisers who are able to sacrifice their travel cost in order to get to their desired destination (Recker, 2001). The word 'utility' was chosen as it characterises the level of satisfaction associated with each alternative (Jara-Diaz, 2007). In other words, utility maximisation is based on the assumption that a traveller maximises the benefits of travel within the limitations of the available resources (Richards and Ben-Akiva, 1975) and choose the travel and activity that maximises perceived net utility.

The resources considered most important when choosing travel options were time and monetary cost of the journey (Richards and Ben-Akiva, 1975), but utility could also be affected by the traveller's taste, socio-economic constraints and time availability (Dalvi, 1978). Goodwin (1978a) used cost-benefit analysis to calculate the utility of travel in terms of the advantages of arriving at a destination compared to the disadvantages of

travelling to that destination. Cost-benefit analysis was based on two main steps: firstly, the enumeration of available travel options and secondly, the evaluation of all the relevant costs and benefits related to the act of travel (Georgi, 1973). The main costs and benefits identified in the transport literature included: increase or decrease in journey costs and changes in journey time, quality of service, frequency of service and safety (Powell, 2001). The final assessment of utility in combination with a traveller's willingness to pay for the journey (expressed as the value of time in monetary units) indicated how much the travel was needed or demanded.

Breheny (1992) highlighted the difference between the need to travel and the demand for travel. For example, if distance, time or financial cost of travel were the only criteria when choosing travel options, people should move closer to their jobs or change jobs so that they could work closer to their homes. Breheny (1992) noticed, however, that facilities located near to housing do not guarantee that local residents will use them. Similarly, Mokhtarian and Salomon (2001) highlight that a more distant shopping centre may be preferred if it offers more variety of products, better prices or a unique item. This would indicate that people have their own strategies when choosing travel to/from facilities and that the two easily measurable determinants of travel (distance and time) are not necessarily the only (or even the main) determinants influencing their travel choices (see Mokhtarian and Ory, 2004).

Since the late 1960s, generalised cost has played an important role in transport planning linking the concept of demand destination and project evaluation (Goodwin, 1978b). In order to improve travel choice assessment and comparison between various travel alternatives, and to avoid price comparisons only, the generalised cost concept was applied (Goodwin, 1978b). Generalised cost is the price a traveller experiences in conducting a specific journey by a specific mode of travel (or multimodal travel)(Powell, 2001). As such generalised cost includes all the costs associated with travel including financial cost, total journey time, discomfort (effort) of the journey, as well as, unreliability and risk associated with the journey and the scenery (the scenery was typically a benefit or a cost) (Powell, 2001). Powell (2001) explained that the first two determinants (monetary cost and journey time) were relatively easy to measure in comparison with the other three determinants mentioned and therefore these 'difficult' variables were usually not given any specific value or were not included in generalised cost calculations. Moreover, this approach to dealing with 'difficult' variables limits the

importance of the psychological aspects of travel behaviour (e.g. personal effort, safety, enjoyment), which are not considered in the generalised cost method at all.

The travel behaviour literature changed substantially in 1998 when Salomon and Mokhtarian published a paper on mobility and accessibility that emphasised the fact that people value mobility (Salomon and Mokhtarian, 1998). Moreover, the authors believed that people might value travel for its own sake. This issue was not new, as transport researchers noticed previously the existence of the phenomenon of travel for its own sake, but always described it as 'rare' (e.g. Richards and Ben-Akiva, 1975; Button, 1993; Jara-Diaz, 2007). Mokhtarian and her colleagues were the first to actually start exploring the reasons behind such economically 'irrational' behaviour where money is spent on travel with the purpose of not only reaching the destination point, but also to derive utility from travel itself. Salomon and Mokhtarian (1998) questioned the simple assumption of residential-employment imbalance leading to excess travel and highlighted that changes in the labour market where the growing and narrowing specialisation influence work location choices. In this context, they highlighted that not only the quantity, but also the quality of jobs available for residents matter, and failure to address this in analysis might lead to 'false' observations of excess travel (Salomon and Mokhtarian, 1998).

Mokhtarian and Salomon (2001) questioned the traditional wisdom that the demand for travel is purely a derived demand. Contrary to the established paradigm that travel cannot be for its own sake, the authors suggested that travel can have some positive utility and can be conducted for its own purpose (Mokhtarian and Salomon, 2001; Mokhtarian, Salomon and Redmond, 2001). Moreover, Mokhtarian and colleagues put forward that positive reasons (e.g. a sense of speed or enjoyment of beauty) why people enjoy 'undirected' travel (meaning a journey without a specific destination) may encourage them to conduct excess travel even for compulsory or maintenance trips (e.g. travel to work). Mokhtarian and her group studied positive utility of travel for the next decade and published a number of papers where they showed that many subjective variables such as travel liking (meaning enjoyment), attitudes, personality, lifestyle etc. contribute to the overall understanding of travel choices (e.g. Mokhtarian and Salomon, 2001; Redmond and Mokhtarian, 2001; Collantes and Mokhtarian, 2002; Ory and Mokhtarian, 2004; Mokhtarian, 2005; Collantes and Mokhtarian, 2007; Ory and Mokhtarian, 2009). Moreover, they stressed that the psychological factors (e.g. the

buffer between home and work, enjoyment) influencing excess travel must not be ignored when studying the phenomenon of excess travel behaviour. These psychological factors are considered in more detail in Section 2.4.2.

2.3 Simple models of excess commuting

Excess commuting, in general, is the extra travel undertaken on a work journey, occurring because commuters do not minimise their travel to work for some reason (Ma and Banister, 2006). Although vague (no parameters specified) this definition highlights the concept of excess commuting, where people spend more resources, such as time, on commuting than an identified minimum amount of the resource. The aim of this section is to compare two different approaches to measuring excess commuting, developed by two pioneers in the field, and show how excess travel has been conceived of, defined and measured.

2.3.1 Monocetric model in excess commuting

Hamilton (1982), who studied commuting behaviour in US and Japanese cities, is perceived as the father of the "wasteful commuting" concept, which he defined as:

> *"the difference between the actual mean commute and the minimised mean commute"*
>
> *Hamilton (1982, p. 1040)*

Hamilton (1982) considered a monocentric urban model comprising of one-worker households with identical tastes, jobs and earnings, while all jobs were located in the central business district (CBD) (White, 1988). In the monocentric urban model land use employment and land use densities decline from the CBD and cities are assumed to be identical in all directions. Residential locations were characterised by distance from the CBD and radial roads formed a transportation network. In addition, Hamilton (1982) assumed that commuters optimise their need for travel taking into account house price and commuting costs.

Hamilton (1982) suggested that wasteful commuting could be removed by encouraging people to swap either jobs or houses until all commute-reducing swaps have been carried out. In Hamilton's model the required average commute (A) was defined as:

$$A = \frac{1}{P}\int_0^{\bar{x}} xP(x)dx \qquad \text{Eq. 2.1}$$

Where x is the distance from the CBD, $\bar{x}$ is the edge of the city (radius at which population density falls to 100 people per square mile), $P(x)$ is the number of people living at distance x from the CBD and P is the total population. Hamilton (1982) assumed that job decentralisation reduces the required commute by the mean distance of jobs from the CBD (B), defined as:

$$B = \frac{1}{J}\int_0^{\bar{x}} xJ(x)dx \qquad \text{Eq. 2.2}$$

Where $J(x)$ is the number of jobs. Thus, the mean required commute, C, is given by A-B and provides the amount of 'wasteful' commuting as the difference between the actual mean commute and the minimised mean commute.

Hamilton's results for wasteful commuting in US and Japanese cities in terms of distance ranged from 70% to 87%. As a result of such a high predictions by the model, where average actual commutes are about eight times greater than that predicted by the model (1.1 miles versus 8.7 miles, respectively), Hamilton (1982) claimed that the monocentric model seriously over-predicts actual commuting distances. He was later criticised by a number of authors (e.g. White (1988)) for his approach and for establishing a framework for excess commuting that removes the urban form component and completely ignores the individual characteristics of commuters (e.g. Charron (2007)) in excess commuting analysis. Moreover, Hamilton (1982) focused his calculations on measuring distance without seriously considering other parameters of travel (e.g. time and effort), which clearly matter in making travel choices, although he mentioned that proportionally more workers walk to work in Japan than in the US.

2.3.2 Linear programming approach to excess commuting

White (1988) re-examined Hamilton's (1982) findings and presented a different approach to calculating 'wasteful' commuting based on cost minimisation using the actual urban structure implemented using a linear programming approach. As Murphy (2009) explained, the linear programming (LP) approach determines the assignment of trips from homes to workplaces that minimises mean commuting cost. The model in this method requires an origin and destination matrix, based on geographical zones, and is

built on the assumption of relocation of workers that minimises the total cost within the urban system (Ma and Banister, 2006). Moreover, the LP approach assumes that perfect information about the travel decisions of other people is available to all, which clearly will rarely be the case in reality. In this context, White (1988) defined wasteful commuting as:

> *"the difference between the average actual time and the average minimum time spent commuting"*
>
> *White (1988, p. 1105)*

It might be assumed that Hamilton and White's definitions of excess commuting are broadly the same. However, in contrast to Hamilton (1982), who used a modelling approach to calculate wasteful commuting in distance units, White (1988) focussed on existing density patterns and measured wasteful commuting in terms of time only. In her calculations she defined the actual average commuting time t (Equation 2.3) and the minimum average commuting time τ (Equation 2.4) as:

$$\bar{t} = \frac{1}{N}\sum_i \sum_j t_{ij} \cdot n_{ij} \qquad \text{Eq. 2.3}$$

$$\bar{\tau} = \frac{1}{N}\sum_i \sum_j t_{ij} \cdot n^*_{ij} \qquad \text{Eq. 2.4}$$

Where N is the total number of workers living in the metropolitan area, t_{ij} is the actual commuting time from the origin (zone i) to the destination (zone j), n_{ij} is the number of workers commuting from i to j and n^*_{ij} is a new number of workers based on optimisation problem which creates a matrix of worker-to-job assignments that minimises the total time spent commuting by all workers in the metropolitan area, where $n_{ij}^* \geq 0$ (see White (1988) for details).

By using this technique White (1988) showed that, for the sample of cities common with Hamilton's (1982) US sample, only 11% of actual commuting was classified as wasteful. Overall, White (1988) criticised Hamilton's monocentric urban model by undermining his assumptions related to the CBD, where differences in jobs and residences distribution were caused by concentration of employment at suburban subcenters. Instead, she proposed a new way of calculating wasteful commuting by applying the existing road network and differing spatial patterns of employment and

residential areas (White, 1988). However, the minimum required commuting (τ) she introduced was derived from the distribution of jobs and housing and did not explain actual commuting behaviour (Yang, 2008). White (1988) was also criticised by Yang (2008) for defining and calculating wasteful commuting on the basis of the distribution of workplace and residence sites, but explaining the subsequent results using the monocentric urban model of dispersed employment (Small and Song, 1992). However, the majority of studies since White (1988) have followed her approach to study the contextual, methodological and policy-related issues of excess commuting.

2.4 The main issues concerning excess commuting

Ma and Banister (2006) distinguished the main issues present in the excess commuting literature as contextual, methodological and policy-related issues. Table 2.1 presents selected examples of literature on excess travel addressing the three issues, where each of them has one or more different focuses (e.g. contextual issue can focus on social, physical or psychological factors) and content (e.g. psychological factors can include the buffer between home and work and value of driving itself). Study areas for each reference are shown (e.g. Los Angeles in Kim (1995)) and mean excess travel distance or time results, if available, are displayed in percentages (e.g. +38.7% mean excess commuting time in Kim (1995)). Moreover, for each reference methodology and data source used, if provided, are described (e.g. standard assignment model method and micro data from 1991 for Los Angeles used in Kim (1995)).

It can be seen that the majority of the study areas presented in the table were in the US, with studies also undertaken for Canada, Ireland, Japan, Korea and UK. 12 of the 21 studies considered in Table 2.1 focused on mean excess travel distance, seven on mean excess travel time and five failed to present any results. Data for the majority of the studies were sourced from various transportation surveys or national census with only two collecting new data via questionnaires. As Table 2.1 shows, the authors addressed various types of problems concerning excess commuting (e.g. multi-worker households, geographical boundaries, transport and land use policies) and the focus of the three following sub-sections is to review these in detail in the context of contextual, methodological and policy-related issues.

Main issues	Focus		Content	Example in the literature				
				Author (Year)	Study area	Mean excess distance/time [%]	Methodology/ data source	Comment
	The reason for excess commuting	Social factors	Multi-worker households	Kim (1995)	Los Angeles, US	-/ +38.7	Standard assignment model/ 1991 micro data	Focus on one and two-worker households
				Builiung and Kanaroglou (2002)	Toronto, Canada	+65.0/ -	1986 Transportation Tomorrow Survey	A policy directed at a specific group has a power of reducing commuting of that group
			Tenancy status	Cropper and Gordon (1991)	Baltimore, US	+50.0/ -	An assignment model/ micro data from The Baltimore Travel Demand Dataset 1977	Examined utility of residential location
			Heterogeneous housing and job markets	Hamilton (1982)	14 US and 27 Japanese cities	+87.1/ +70.0	Monocentric model / US and Japanese travel data	First paper on wasteful commuting
				Manning (2003)	London, UK	+55.0/ -	1993-2001 Labour Force Survey and 1991-2000 British Household Panel Survey	Disaggregation analyses have little impact on the excess commuting estimates
			Different tax subsidy systems	Merriman *et al.* (1995)	Tokyo, Japan	-/ +15.0	1985 census	Very small excess commuting for Tokyo (public transport only)
			Minority groups	White (1988)	25 US cities	-/ +11.1	Linear programming calculation (time)	Response to Hamilton's (1982) paper
		Physical factors	Lack of driver's route-optimisation skills	King and Mast (1987)	US	+6.4/ +12.2	Proportions/ Previous studies and new data	Focused on excess driving in US and factors linked to drivers skills (car only)
			Misperceptions and lack of information	Handy *et al.* (2005)	Austin, US	N/A	Questionnaire, 43 university employees	Identified nine different examples of excess driving, but did not measure the amount of excess driving
			Imperfect labour market information	Rouwendal (1998)	N/A	N/A	Used mathematical formulas for calculating spatial interactions	The main focus on modelling spatial interactions between residential and employment locations
		Psychological factors	Buffer between home and work	Charron (2007)	50 metropolitan areas, US	N/A	Census Transportation Planning Package	Studied commuting possibilities in the context of excess commuting
			Escape	Ory and Mokhtarian (2004)	San Francisco Bay Area, US	N/A	Questionnaire, 1358 residents	Modelled the affinity for travel
			Value of driving (travelling) itself	Handy *et al.* (2005)	See above			

Methodological	Boundaries and measures	Geographical boundaries	Murphy (2009)	Dublin, Ireland	+50.0 (1991, public transport); +78.4 (2001, private transport)	1991 and 2001 Dublin Transportation Office	Disaggregated modal choice analysis for two time periods (public and private transport)
			Frost *et al.* (1998)	10 UK cities	+19.1/ -	1981 and 1991 census/Spatial Workplace Statistics	Decentralisation of employees is important in excess commuting estimates
			Horner and Murray (2002)	Boise, US	+26.2-48.1/ -	N/A	Level of aggregation has a considerable impact on the excess commuting estimates
		Different measures	Scott *et al.* (1997)	Hamilton, US	-/ +73.14	1986 census	Large proportion of excess commuting cannot be explained by geographical distribution (car only)
			Small and Song (1992)	Los Angeles, US	+69.1/ +65.9	Linear programming calculation/1980 Census data	Linked back to Hamilton and White's and explained the difference in methodologies
		Spatial structure	Yang (2008)	Boston and Atlanta, US	5.5 km (1980, Boston); 11.7 km (2000, Atlanta)/ -	1980, 1990, 2000 census data	Investigated changes in metropolitan spatial structure
			Suzuki and Lee (2012)	US, Japanese and Korean cities	N/A	Data based on Horner (2002) and Lee *et al.* (2006)	Used continuous urban structure to calculate unbiased excess commuting
Policy	Jobs-housing balance	Transport and land use policies	Horner (2002)	26 US cities	+46.8/ -	1990 census	Explored a concept of the theoretical maximum commute
			Fan *et al.* (2011)	North California, US	+30.5%/ -	2006 Greater Triangle Travel Study (24-hour travel diary)	Suggested policies leading to improvements in school quality and neighbourhoods

Table 2.1 Selected literature on excess travel research presented in the context of three main issues concerning the phenomenon.
Source: based on the concept presented in Ma and Banister (2006)

2.4.1 Methodological issues

Ma and Banister (2006) observed that the methodological issues in the excess commuting literature have concentrated around three major approaches: geographical boundaries, travel cost measures and the spatial structure of the city.

2.4.1.1 Geographical boundaries

It has been shown by a number of researchers (e.g. White (1988), Small and Song (1992), Merriman *et al.* (1995), Frost *et al.* (1998), Niedzielski (2006)) that geographical boundaries of a study area play an important role in the assessment of the presence of excess commuting in an area. The origin and destination matrix used in transportation models is usually based on administrative zones (Ma and Banister, 2006). However, variations in the size and the number of zones used (e.g. White (1988), Small and Song (1992)) will influence the excess commuting results derived. It has been observed that, even when similar approaches are applied, the proportion of excess commuting is reduced when lower level zones (small number of large zones) are used. Ma and Banister (2006) explain that this is due to the transportation optimisation model operating between the zones and does not consider internal changes of jobs or residential places within a zone to minimise commuting. This means that when the number of zones is one, excess commuting is zero as it does not account for intra-zonal trips.

Small and Song (1992), who investigated a sample of residents in Los Angeles, US, showed a difference in excess commuting between aggregated and disaggregated data. The authors' results for large (aggregated) zones showed that about 30% of the actual commuting was excessive, whereas for small (disaggregated) zones the result of excessive commuting was about 65% of all commuting. Merriman *et al.* (1995), who used data for the Tokyo metropolitan area also showed that excess commuting was greater when disaggregated zones were used, although the difference between the results for disaggregated (n = 211) and aggregated (n = 16) zones was small (15% and 12% of excess commuting, respectively). Horner and Murray (2002), who analysed commuting in Boise, US, showed that excess commuting results for disaggregated zones were higher, although their average proportions were lower than the results in Small and Song (1992)(48% for disaggregated n = 275 zones and 26% for aggregated n = 25 zones). The above examples show different results as the authors used different measures (e.g. distance versus distance and time).

The differences in excess commuting results for the same areas are related to the Modifiable Areal Unit Problem (MAUP)(Ma and Banister, 2006). The MAUP occurs when the boundaries in the study area are randomly modifiable (Ma and Banister, 2006). The literature suggests a specific set of issues in excess commuting analysis which are related to the MAUP and caused by various approaches to defining geographical boundaries. Examples of such issues are presented in Figure 2.1. The first MAUP issue related to scale arises when the number of zones is reduced and areas with different characteristics that are located next to each other are combined (Figure 2.1 top).

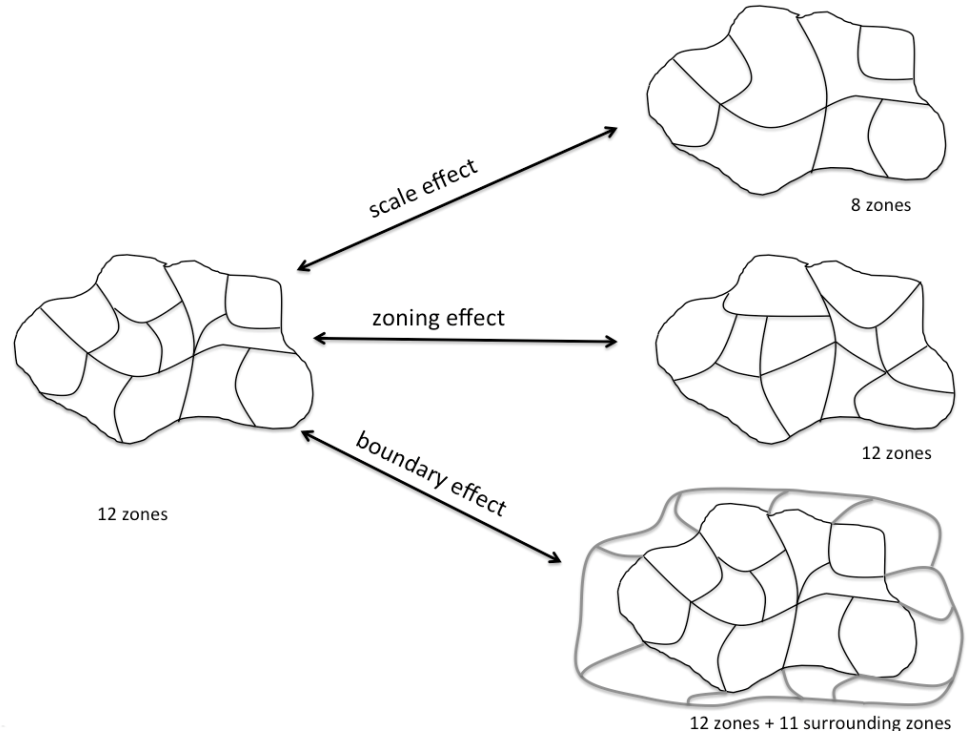


Figure 2.1 Three examples of possible biases caused by subjective geographical boundaries. Source: based on Ma and Banister (2006)

The second issue is a zoning effect and it occurs when the number of zones in the original and the new study is kept the same (Figure 2.1 middle), but the actual boundaries are moved within the area. This approach can also lead to different results, because of, for example, differences in residents' socio-economic characteristics (which might influence travel choices) between the original areas and the areas with the new boundaries. Finally, the third issue is a boundary effect where results for inner zones only, and the results for an area where outer zones are added (Figure 2.1 bottom) might vary. For example the original zones might include residential areas with workplaces, but when external residential areas without workplaces (surrounding zones) are added to

the new study area this can influence the excess commuting results for the sample (Frost *et. al.*, 1998).

A solution to the MAUP with zonal aggregation bias has been suggested by a number of authors who used individual-level micro-data (Cropper and Gordon (1991), Small and Song (1992), Kim (1995), Fan *et al.* (2011)), as the use of such data was not affected by the problem. Fan *et al.* (2011) suggested a new approach to the MAUP where they estimated excess travel at the household level without involving any area configuration (see Figure 2.3).

The problem of boundary effects was investigated by Frost *et al.* (1998), who examined the impact of the position of city boundaries on excess commuting results. The authors used 1981 and 1991 census data for 10 British cites and included inward commute (commuting performed by people who live outside the city boundaries but work within the city boundaries). Frost *et al.* (1998) found that the proportion of excess commuting is smaller when inward commuting is included in the model, due to surrounding zones being mainly residential areas, a finding that highlights the importance of spatial structure. For example, when the areas surrounding a city are mainly residential, then extending the boundary of the study area by including the surrounding residential areas is likely to lead to smaller excess commuting because limited workplaces are available in those areas and therefore the minimum commute increases faster than the actual commute (Ma and Banister, 2006). However, if the city surrounding areas have a more industrial character, and therefore offer workplaces, then the results of excess commuting with those areas included in calculations might increase.

Niedzielski (2006), who studied Polish cities and applied a disaggregated approach, found that excess commuting varies from 48% in Warsaw to 67% in Łódź. This work also showed that, for his sample of four large cities, commuting efficiency was higher for peripheral locations than for central locations and higher for job-poor areas than for job-rich areas. The reason for this was that employers in job-poor areas attract workers with the shortest minimum commutes whereas in job-rich areas the opposite occurs. Niedzielski's (2006) results confirmed that geographical boundaries applied in the analysis influence results of the minimum commute as well as commuting efficiency, which is higher in larger cities due to more commuting possibilities.

Overall, it has been suggested by a number of authors (e.g. Horner and Murray (2002), Niedzielski (2006)) that the geography used in excess commuting analysis should be as disaggregate as possible. Therefore it is recommended to collect data an individual level when possible as disaggregated data allows for a better estimation of the true amount of excess commuting.

2.4.1.2 Different measures of excess commuting

The two parameters used most frequently to measure excess commuting are travel time and distance (Small and Song (1992), Kim (1995), Frost *et al.* (1998), Ma and Banister (2006), Banister (2011)) and no significant differences were found in excess commuting results when using time or distance (Small and Song (1992); Giuliano and Small (1993), Scott *et al.* (1997)). Moreover, Fan *et al.* (2011) stated that distance is a reasonable proxy of travel time for their sample of 2,886 households in North California, US. However, Ma and Banister (2006) re-examined the relationship between time and distance and noted that if time is not proportional to distance, the use of different parameters may lead to different results in excess commuting. Some evidence for this was given by Hamilton (1989) and Ma (2004), who assumed that commuting time has a positive relationship to distance. Figure 2.2 presents the relationship between commuting time and commuting distance with results from Seoul, South Korea plotted (Ma, 2004). The graph compares commuting time and commuting distance for three sets of data (1990, 1995 and 2000) and shows that the relationship between the two parameters is definitely positive. However, Figure 2.2 shows that time is not linearly proportional to distance, which might lead to lower excess commuting results for time than for distance parameter.

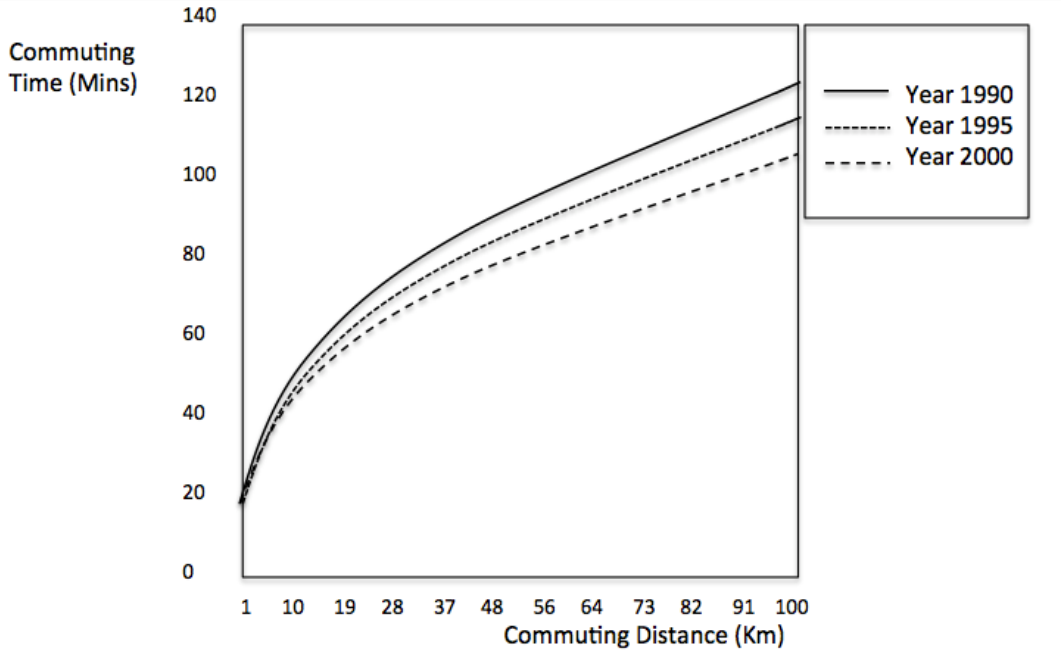


Figure 2.2 Relationship between commuting time and commuting distance. Source: based on Ma and Banister (2006)

As the literature suggests, an important consideration in the comparison of time and distance, in the excess commuting context, is the way the parameters are calculated as this influences the results obtained. Travel distance could be calculated as a straight line (Hamilton, 1982) or network distance (White, 1988), where the second option reflects the real situation (e.g. road network). Travel to work time can be measured as door-to-door commuting or in-vehicle travel time, where the latter does not include time of access to and from a transport mode (e.g. to and from a car, Merriman *et al.* (1995)). Therefore the technique used to calculate excess commuting parameters (e.g. time and distance) will determine whether the results obtained are realistic to achieve in real life or remain theoretical. Moreover, comparing results from different studies, where times or distances were calculated using different methods is difficult, as assumptions used in the methods (e.g. travel time measure) will affect the amount of excess commuting derived (see results for Los Angeles in Table 2.1).

Ma and Banister (2006) argued that commuters see time as the main constraint to where they work and are more concerned with travel time rather than travel distance. They said that, for example, faster cars can help to overcome the commuting distance, but it is still the time that people care about, giving as intuition that individuals consider the time to be the main constraint to where they work. This argument was supported by Cook (2009), who showed that people have been travelling to work on average for an

hour and a half a day, whether they live in a city or in a rural town. She argued that the travel time budget has stayed constant over many decades, although travelling habits and technology have changed. People in the 21st Century are able to use faster modes of transport (e.g. cars, trains, planes) and travel greater distances within the same amount of time (Cook, 2009). Moreover, her predictions are that people will travel even further distances in the future when new technologies are available (Cook, 2009). This is important in the excess commuting context, as the parameters used to measure time, distance or value of commuting time, as well as their importance in mathematical equations are expected to influence excess commuting results.

Although time and distance are the travel parameters used most commonly in excess commuting studies, there are also other parameters, for example physical effort or monetary cost, which are much more difficult to quantify due to individual constraints (e.g. individual perception of effort, make of a car, fuel consumption, insurance etc.). For example, the measurement of effort relies on asking travellers attitudinal questions regarding stress (Stradling, 2002) or checking their blood pressure (Novaco, 1992). Although Stradling did some work on travel effort and psychology of transport (Stradling (2000, 2002, 2011)), effort as a parameter has not been considered in the excess travel literature so far.

Monetary units have been used in various transport studies (Jun and Hur (2001), Brownstone and Small (2005), Chang (2010)), but not in the context of excess travel. The reason for this might be the difficulty in collecting accurate data on actual travel costs and cost of alternatives from samples where people use different transport modes and have different costs associated with their travel (e.g. drivers who own different types of vehicles, pay different insurances etc., public transport users who pay different fees for their travel depending on their age, occupation and distance of travel). As Gordon and Cropper (1991) stated, this difficulty might lead to a number of assumptions regarding the value of time and travel mode which might influence the final excess commuting results calculated.

In addition, in recent decades, the transport impacts on the environment and the promotion of eco-friendly modes of transport (e.g. walking, cycling, and car share) have put an emphasis on measuring gas emissions linked to individual travel (CO_2/kg) or fuel consumption (litre/kilometre). However, a lack of implementation of these 'new'

parameters (e.g. effort, monetary cost, gas emissions) in excess commuting calculations suggests that they are perceived as more complicated to measure than time and distance, perhaps because of the number of detailed socio-economic as well as travel-mode parameters related to individuals which need to be taken into account in calculations. This is probably one of the main reasons why time and cost are still the key parameters used in excess commuting calculations.

2.4.1.3 Spatial structure

Excess commuting has been used as a tool for understanding the relationship between travel efficiency, which evaluates the spatial relationship between residential and employment locations, and urban structure (Fan *et al.*, 2011). The traditional approach to excess commuting assumed that jobs and housing could be optimally distributed according to some (e.g. spatial) criteria (Hamilton (1982), Chen (2000), Yang (2008)). Ma and Banister (2006), who studied commuting in Seoul, South Korea using census data from 1990 and 2000, showed that urban spatial change, such as the growth of cities over time, influence job-housing imbalances and leads to higher levels of excess commuting. Yang (2008), who studied changes in metropolitan spatial structures, found that in Atlanta and Boston, US, the transport–land use connection has become weaker over the decades (Yang (2008) used census data from 1980, 1990 and 2000 for Atlanta and Boston, US) as the new job and residential developments change the dynamics of commuting. He explained that the reason for this is that residential location choices tend to follow patterns of 'average job location' rather than the 'closest available job location' and this affects the level of commuting as well as influencing the amount of excess commuting undertaken.

On the other hand, Fan *et al.* (2011) found that households living in compact developments with mixed residential and activity locations show a tendency to concentrate their daily activities in smaller geographical areas, which leads to reductions in the amount of the additional travel undertaken. They illustrated the relationship between required travel and activity locations (Figure 2.3) and showed clearly that household location influences the amount of excess travel (including excess commuting). The optimal home location, presented in Fan *et al.* (2011), is based upon existing activity locations and travel patterns and is not influenced by the current home location. Although quite abstract, this concept illustrates in a simple way the excess commuting phenomenon, where in theory people (households) could travel less to

closer destinations, but in reality for various reasons they choose leisure, work and other destinations located further from home. This concept also confirms the argument of the net utility people get from travel, where attractiveness of the further destinations compensates longer travel.

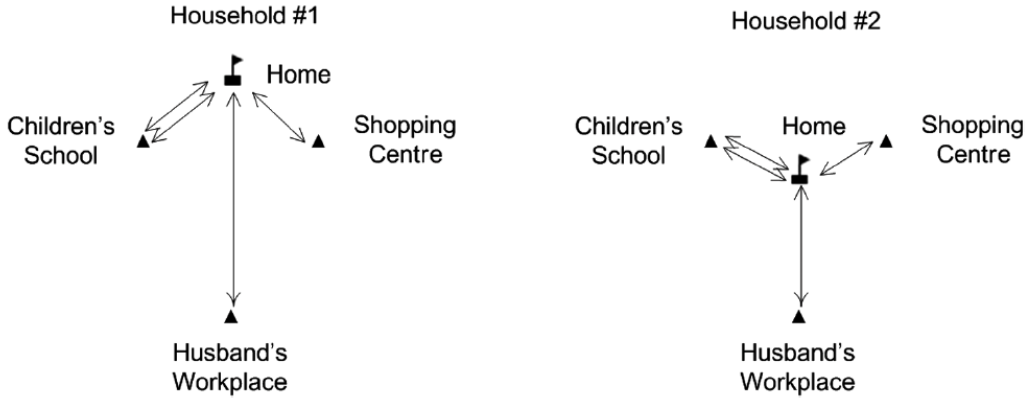


Figure 2.3 Relationship between required travel and activity locations: a. household with greater excess commuting; b. household with smaller excess commuting. Source: Fan *et al.*, 2011, p. 1241.

Figure 2.3 shows the essence of Fan *et al.* (2011) study where they focused on the relationship between land use, household location and travel efficiency. Their overall conclusion was that spatial structure of the study area is important for measuring excess commuting. However, the authors noticed a number of limitations of their technique, such as identifying areas for relocation, which might not be suitable for housing developments or using data from 24-hour travel diaries, which might not include all necessary trips for the households. Fan *et al.* (2011) also highlighted the fact that the spatial structure studied can be specific for the study area only (e.g. the Triangle region in North California with 50% population increase in the last decade), therefore the results from one study cannot necessarily be generalised to other study areas.

The methodological issues related to excess commuting research highlight various concerns associated with the geographical boundaries applied, different parameters used and diversity of spatial structure of case study areas. All these three elements are important when comparing excess commuting results between different study areas, especially when different data sources (e.g. census data versus travel diary), different aggregation methods (e.g. boundary effect) and different measures (e.g. time versus distance) have been used (Ma and Banister, 2006).

2.4.2 Contextual issues

Ma and Banister (2006) emphasised that the literature has identified a number of factors (e.g. multi-worker households or minority groups) preventing urban workers from finding local jobs or residential locations, thus creating longer travel to work journeys and a higher level of excess commute. These factors, named as 'contextual factors' by Ma and Banister (2006), can be divided into three main groups: social, physical and psychological.

2.4.2.1 Social factors

Social issues relate to the housing-job balance and form the largest group of factors causing excess commuting (Ma and Banister, 2006). A number of authors suggest that social dimensions such as security in the area or school quality (Fan *et al.*, 2011), as well as household structure (Cropper and Gordon (1991), Kim (1995), Buliung and Kanaroglou (2002)) or the presence of minority groups (White, 1988) are important when addressing transport problems. Cropper and Gordon (1991) noticed that two-worker or *multi-worker households* have more limitations than single-worker households when deciding on household location and commuting options. The authors used the Baltimore Travel Demand Dataset from 1977 and assumed that commuters choose their household locations based on utility maximisation. The authors assumed that the utility received by household *h* from house *j* is a function of housing (Y_h – household income; P_j – the annual cost of house *j*) and neighbourhood attributes (Z_{hj} – vector of housing and neighbourhood attributes associated with the house), commuting distances of primary (D^1_{hj}) and secondary (D^2_{hj}) workers in the household, and all other goods. The authors defined the utility as:

$$U_{hj} = \alpha \ln\left(Y_h - P_j\right) + Z^1_{hj}\beta + \gamma_1 D^1_{hj} + \gamma_2 D^2_{hj} \qquad \text{Eq. 2.6}$$

Based on results achieved, which showed that there are differences in length of primary and secondary commute between home owners and renters, the authors suggested a definition of the average required commute, which minimises total commuting distance and is constrained with rearrangements of households to reduce commutes. Cropper and Gordon's (1991) results for the average minimum distance commute were much higher than Hamilton's (1982) (3.69 miles compared to 0.68 miles), because the authors used actual residential and job locations, and actual road distances (Hamilton's monocentric model assumes a radial network of roads).

Kim (1995), investigated single and two-worker households separately, and found that multi-worker households in his sample of Los Angeles Metropolitan Area behave differently in relation to travel to work and location choice. The results showed that the average actual commuting distance for two-worker households is 15.3 miles for the primary worker and 12.1 miles for the secondary worker and for single-household worker the distance is 15.5 miles. Kim (1995) concluded that single-worker households commute longer distances and have more excess commuting than two-worker households (38.11% versus 21.92%, respectively). In addition, Buliung and Kanaroglou (2002) demonstrated that the amount of excess commuting is reduced when the additional constraints (e.g. gender, children) on the mobility of multi-worker household are applied. The authors studied Greater Toronto, Canada and their calculations showed that household composition (e.g. male auto-drivers household, females in single-worker household with children) strongly affects commuting distance and excess commuting. For example, excess commuting for the sample without any mobility restrictions (all individuals) was 65%, while for males in full-time employment it was 43% and for females in multi-worker households without children it was 10% only. The results presented by Buliung and Kanaroglou (2002) indicated that commuter demographics in combination with the spatial distribution of workers and jobs affect excess commuting.

Tenancy status has an important role to play in excess commuting as some evidence has shown that in general homeowners have greater moving costs (Crane, 1996) and this may affect their mobility (Cropper and Gordon, 1991). For example, Cropper and Gordon (1991) created two models of residential location choice, one dedicated to homeowners and the other one to renters. The models included over 20 variables related to housing (e.g. family size), commuting (e.g. length of primary and secondary commute) and neighbourhood (e.g. population per acre). In contrast to Hamilton (1982), they found that distance between home and work is important to households in making their location decisions. Cropper and Gordon's (1991) results showed that the average required commute for homeowners was greater than for renters (5.04 miles and 4.17 miles, respectively). The authors, who used data from 1977, concluded that the average excess commuting in Baltimore, US is about 5 miles, and excess commuting for homeowners is lower than for renters (56.96% versus 64.22%, respectively). Overall they concluded that homeowners have a longer average commute but less excess commuting compared to renters, and this might be explained by renters' greater flexibility in terms of mobility. Kim (1995), who also investigated tenancy status,

concluded that in single-worker households tenants are more likely to have slightly higher levels of excess commuting than homeowners (33.16% versus 32.55%), and slightly lower excess commuting results than two-worker households (19.64% versus 21.48%).

A number of studies have highlighted the importance of taking into account *future job locations* when studying excess commuting (e.g. Crane (1996), Van Ommeren (1998)). Crane (1996) argued that people with unstable jobs are likely to have longer commutes (job uncertainty reduces the value of access to the current jobs), but also noticed that the life cycle of the household might influence its commute length (e.g. a plan to buy a house might affect the level of current commute). However, no results were presented to indicate how significant this influence is. Van Ommeren (1998) showed the correlation between the probability of being engaged in job search and commuting time and argued that excess commuting could be associated with the expectation of job moving in a way that current excess commuting would be reduced due to a closer job location in the future.

The next social factor is *heterogeneous housing and job markets*. Hamilton (1982) highlighted that heterogeneity, where high-income household and low-income jobs are concentrated in the suburbs and low-income housing and high-income jobs are in the city centre, influences the volume of commuting within the city boundaries and as a consequence can be one of the determinants of excess commuting. Giuliano and Small (1993) and Manning (2003), who studied heterogeneous residential and employment markets, concluded that segmentation of the labour market must not be ignored in excess commuting analysis. They argued the obvious, that it is not always possible to swap jobs between workers working in area A and living in area B and vice versa, as they might have different professions or different pay variations (Manning, 2003).

Excess commuting research has been undertaken in various countries and cities with different public and private transport policies and different *tax subsidy systems* in place. For example Merriman *et al.* (1995) suggested that in the US commuters encouraged by untaxed compensation of free parking may use cars more often, where in Japan tax-free transit tickets encourage more commuters to use public transport, so that they limit their car journeys. Cervero and Landis (1995) emphasised that the transport subsidy policies in the US allow drivers to perceive their travel cost as being much lower than they are in

reality, leading to a lowering in the importance of distance travelled. Van Ommeren *et al.* (2000) agreed that transport subsidy systems have a negative impact on worker's commute time (which increase), as they make workers less sensitive to the monetary costs of commuting. Overall, tax subsidies may encourage travel behaviour where workers travel longer distances and spend more time commuting, as they do not have to worry as much as non-subsidised commuters about the amount of money they spend on travel. Moreover, access to a free company car may encourage some workers to move to a further location, as the financial cost of travel is reduced for the household (Van Ommeren *et al.,* 2000) and this in consequence may lead to 'intentional' excess driving behaviour (Handy *et al.*, 2005) (see section 2.4.2.3).

Minority groups occupying specific areas of the city might influence the level of excess commuting in that city. White (1988) suggested that a high proportion of workers from black and minority ethnic groups (BME), for example in the US, may face discrimination in either housing or job markets (e.g. might be less mobile), and that this forces them to live in BME communities (without taking into account job location) and in consequence potentially commute longer distances to work. This then generates higher excess commuting in cities with a high proportion of BMEs (White, 1988). However, no other literature was found to investigate this issue further.

Ma and Banister (2006) mentioned a number of other social factors, such as: the transaction costs of moving jobs or housing or rapid job turnover, which could explain excess commuting to some extent. However, they also noted that these factors have not yet been included in excess commuting models, so it is difficult to judge their overall importance in the phenomenon.

2.4.2.2 Physical factors

The excess commuting literature has identified a small number of physical factors, which can to a certain extent explain 'more than necessary' travel (King and Mast (1987), Handy *et al.* (1995)). Examples of such physical factors include cases where travellers do not have enough (or good) information about the local labour market, their travel (driving) skills are not good enough or they base their travel decisions on misperceptions (see 'unintentional' excess driving factors in Table 2.2). All these physical factors are linked to travellers' (limited) skills and their route knowledge.

King and Mast (1987), who studied excess travel in the US, concentrated on one specific mode of transport – a car, and offered a comprehensive description of the phenomenon of excess travel related to driving. Their definition of excess travel was:

> *"the arithmetic difference between total actual highway use, exclusive of destination-free "pleasure" driving, and the use that would have resulted if all such travel had been made by using the optimum route connecting each individual origin-destination pair"*
>
> *King and Mast (1987, p. 126)*

They concluded that excess travel was caused by a number of factors focused mainly around *lack of driver's route-optimisation skills* (e.g. route selection criteria). The authors focused on the aspect of excess travel due to navigational waste and distinguished between excess distance and excess time. They estimated the excess travel for work trips at 4% of distance and 7% of time while for other trips (with unfamiliar destinations) the results of excess travel were 10% of distance and between 10% and 30% of time. In addition, excess travel due to navigational waste, resulted in excess travel at 6% of the distance travelled and 12% of time. Although King and Mast (1987) did not focus on excess commuting explicitly, their publication introduced one-mode specific study and provided a useful list of physical factors causing excess driving. Their explanation of excess travel highlights the importance of better understanding the way people make travel decisions (e.g. lack of information or driving skills). It is expected that developments in satellite navigation (e.g. TomTom navigation and location-based products for drivers), achieved over the last few decades are helping to reduce the type of excess travel which King and Mast (1987) have elaborated.

Handy *et al.* (2005) suggested that driver's *misperceptions* and *lack of information,* about the route followed and its current state (e.g. level of congestion or number of accidents for drivers; familiarity with bus timetable for public transport users), could lead to excess travel (see Table 2.2). Rouwendal (1998) suggested that *imperfect labour market information*, when workers do not have enough knowledge about jobs available in the area, may force individuals to commute longer than necessary. Therefore due to imperfect knowledge (lack of clear directions on the road, clear road signs, easy-to-read instructions etc.) as well as ignorance with regard to available public transport services people do not always make the most efficient travel choices which then might lead to

excess travel (commuting) behaviour (King and Mast, 1987; Handy *et al.*, 2005). The ignorance of drivers with regards to public transport offer, mentioned in Handy *et al.* (2005), highlights an important prejudgement amongst drivers that public transport is not an option for them, even though they do not have details of services available (e.g. routes, timetable, comfort).

2.4.2.3 Psychological factors

Some authors agree (Buliung and Kanaroglou, 2002) that excess commuting studies can be criticised for ignoring the behavioural content of commuting and also for employing a number of simplifying assumptions (Buliung and Kanaroglou, 2002). Others (e.g. Ma and Banister (2006), Niedzielski (2006)) clearly note that in addition to physical and social factors, there may be some psychological factors, linked to positive utility of travel, influencing excess commuting.

A buffer between home and work was identified as one of the first psychological reasons why people perform excess commuting (Giuliano and Small, 1993; Salomon and Mokhtarian, 1998; Charron, 2007). Giuliano and Small (1993) found that commuting time plays a very limited role in choosing residential location, and hypothesised that travel to work trips may act as psychological buffer between home and work activities. Charron (2007) stated that commuting both connects and separates home and work environments, and that individuals express their tolerance to commute as they get some benefit out of it (e.g. buffer time). Niedzielski (2006) also mentioned that longer than necessary travel to work is not necessary wasteful, as it offers positive social effects of the commuting interaction and minimises the level of social exclusion, where short commuting significantly reduces interaction. Jain and Lyons (2008) found that travel time could be perceived as a gift, the only time when travellers (commuters) are not playing any roles (e.g. husband at home or manager at work) and have this time for them only to think, relax or do other activities (see Russell *et al.* (2011) for details of what passengers do with their travel time). This 'escape' time from the stresses of family obligations and other domestic situations, as identified by Ory and Mokhtarian (2004), is another reason why travel might have a positive utility and can be desired by some individuals. Therefore travel might be chosen even when other options for work (e.g. teleworking) or shopping (e.g. e-shopping) are available. In addition, Ory *et al.* (2004) found that larger household sizes increased the propensity for commuting travel and excess travel.

A definition of excess travel inspired by the positive utility of travel approach appeared in Salomon and Mokhtarian (1998). The authors, who took a psychological approach to excess travel, understood excess travel as:

> *"travel that exceeds what could be a minimum satisfying level"*
>
> *Salomon and Mokhtarian (1998, p. 132)*

Although 'satisfying' implies utility, they did not explain what the satisfying level actually meant and what parameters of travel should this 'excess' apply to. However, based on the previous literature (e.g. Small and Song, 1992; Maggi *et al.*, 1995) they brought together factors which might be causing excess travel. The list of selected factors included physical factors (e.g. ignorance with regard to the road network structure), sociological (e.g. two-worker household and constraints on the individual) as well as some psychological factors linked to positive utility of travel. The latter included: utility derived from travel itself, the utility derived from certain lifestyles associated with mobility and desire to experience physical space (Salomon and Mokhtarian, 1998). The authors also agreed that the buffer between home and work is an important factor influencing commuting behaviour.

Mokhtarian *et al.* reflected on excess travel to enrich their definition. Mokhtarian *et al.* (2001), who studied attitudes toward travel in San Francisco Bay Area, US, stated that:

> *"Excess travel is when that more distant destination or longer route is chosen"*
>
> *Mokhtarian et al. (2001)*

Mokhtarian *et al.* (2001) measured excess travel qualitatively and asked respondents questions related to their engagement in 'unnecessary' travel (e.g. travelling mainly to be alone) offering a three-point answer scale (never/seldom, sometimes and often). They did not use any zones in their sampling and did not focus on residence-employment imbalance, as the priority of their research was to investigate the demand for travel. Therefore the authors did not quantify clearly what 'more' meant in their excess travel definition or what the optimum value of distance and time should be. 'More' distant or 'more' time meant only more than necessary, which was still far from a precise quantitative measure.

However, a more detailed definition of excess travel was presented by Mokhtarian and Salomon (2001) where they claimed that:

> *"Excess travel is a travel where lower cost, time and/or vehicle kilometres-travelled alternatives are available but not chosen because of an intrinsic desire (or a positive utility) for travel"*
>
> *Mokhtarian and Salomon (2001, p. 699)*

This definition highlighted not only time and distance, but also the monetary cost of travel as the three main parameters of excess travel; although the cost parameter was not explicitly explained. By deliberately including positive utility in the description, the authors stressed that utility of travel can be independent of the destination of the journey. Moreover, Mokhtarian and Salomon (2001) highlighted that the utility of the destination itself may not be the most important generator of the trip, even for mandatory trips like travel to work. For example, telecommuting can be an alternative to commuting, but the National Travel Survey conducted in Great Britain in 2012 showed that only 5% of employed people worked from home (Department for Transport, 2013). However, even when telecommuting is an option for some reasons (e.g. escape) in some cases (e.g. family obligations) it may not be chosen. This implies that benefits gained from the travel itself can lead to unnecessary or excessive use of the resources of cost, time and distance (Mokhtarian and Salomon, 2001). Although not deliberately stated in the definition, the description of excess travel using vehicle-kilometres travelled suggests that it was specifically related to driving and other modes of transport were not considered. The reason why Mokhtarian's research is focused mainly on drivers is influenced by the way US society is very car-dependent (Ory and Mokhtarian (2004), Handy *et al.* (2005)).

Over the years Mokhtarian and her group focused on psychological reasons why people undertake excess travel. Redmond and Mokhtarian (2001) identified potential explanatory variables for travel behaviour models, which included ten groups: objective mobility, perceived mobility, relative desired mobility, travel liking, attitudes, personality, lifestyle, travel modifiers, demographics and excess travel. The authors found that excess travel may be positively related (e.g. demonstrating strong desire for all travel) as well as negatively related to desired commuting time depending on individual circumstances (Redmond and Mokhtarian, 2001). Moreover, Ory *et al.*

(2004) found that both the psychological impact of commuting, as well as the amount of time people want to spend commuting are influenced by their enjoyment of commuting. Therefore some people might be more resistant than others to policies aimed at reducing commuting time (Ory *et al.*, 2004).

Another example of a contribution to the understanding of excess travel was published in Handy *et al.* (2005), where the authors focused on driving and argued that driving by choice is different from driving by necessity as the first assumes freedom of choice while the second approach implies a limited number of alternatives. The authors defined excess driving as:

> *"driving above and beyond the required level and can be generated by the choice of longer routes, father destinations, greater use of the car, and more frequent trips than the minimum required"*
>
> *Handy et al. (2005, p. 185)*

This definition suggests that excess travel is travel above a minimum level. The authors mention four parameters that are important for travel: route length (longer), distance (farther), use of the car (greater), and trip frequency (more frequent than minimum). Handy *et al.* (2005) used three focus groups and 43 in-depth interviews with the University of Texas employees to investigate the excess driving phenomenon. Based on their observations they identified seven main reasons for excess driving that could be grouped into two broad categories of intentional and unintentional excess driving (travel)(Table 2.2).

Category	Reasons for excess driving	Example statement
Intentional	Value of driving itself	"I enjoy driving. I love driving. I just enjoy it."
	Value of activities while driving	"I just wanted to hear the rest of this book that I was listening to. So, I got in the car and drove to the store and bought something and came back. But it was really unnecessary trip."
	Variety seeking	"I don't know, just sometimes I want to go someplace different."
Unintentional	Habit	"You know there is something shorter but you take the way you know because it works."
	Poor planning	"I could plan better to do more things in one trip rather than making a trip and then making another trip and then another trip. It is probably because of not planning."
	Misperceptions	"I'm not sure that I took the shortest route. I perceive it to be the shortest route."
	Lack of information	"I don't know anything about the bus timing and how to get there."

Table 2.2 Factors identified in the literature as causing excess driving. Source: Adapted from Handy et *al.*, 2005

Table 2.2 clearly shows Handy *et al.* (2005) distinguished between intentional and unintentional reasons for excess driving and gave several examples of the factors in each category. The example statements presented in Table 2.2 demonstrate that people have different reasons for driving other than the reason that the journey is necessary to reach a destination. Excess driving can occur because of the enjoyment of driving or as a consequence of a habit or poor planning of the journey (this factor was also mentioned by King and Mast (1987) and Small and Song (1992)). Handy *et al.* (2005) showed that some people might undertake excess driving because they want to (intentional), while others are forced by other factors to travel more than they wish to (unintentional) and they might not even realise that they are undertaking excess travel. Handy *et al.* (2005) highlighted that an individual's choice with regards to route, destination, mode or frequency can influence the excess travel behaviour. However, the authors admitted that, even for commuting, the issue of excess driving is complicated. Although trip destination or trip frequency for travel to work are usually fixed, other variables such as travel route or transport mode might still involve some degree of freedom, where minimum requirements might be difficult to define, therefore difficult to measure and compare against the required (or minimum) level of driving.

2.4.3 Policy issues

Since the early days of excess commuting research authors (e.g. Hamilton (1982), White (1988), Rodriguez (2004)) have had an aspiration for the phenomenon to be used as a tool for influencing land use and transport planning and policy (Fan *et al.*, 2011).

The traditional concept of excess commuting implies that people (for some reason) travel more than necessary and that savings in the amount of commuting undertaken could be achieved by having a better jobs-housing balance (bringing jobs and homes closer together) (Hamilton (1982), Suzuki and Lee (2012)). A jobs-housing balance can affect the level of traffic congestion and emissions (Scott *et al.*, 1997). Scott *et al.* (1997), who used Hamilton's (1982) Census Metropolitan Area in Canada as a case study, examined excess commuting in the context of potential reductions in vehicle emissions. The authors compared two commuting scenarios (the actual and the optimum scenario) and measured emissions of hydrocarbon (HC), carbon monoxide (CO) and nitrogen oxides (NO_x) for both. Scott *et al.* (1997) suggested that by encouraging more efficient commuting the emissions of HC, CO and NO_x could be significantly reduced. In addition, they criticised the policy that advocates a better jobs-housing balance as the main strategy for encouraging efficient commuting and highlighted that commuters take into account commuting costs as well as many other factors when choosing their residential locations. Therefore, as Scott *et al.* (1997) concluded, geographical imbalances of employment and residential areas itself cannot explain excess commuting fully.

Some researchers showed that the length of commuting trips could vary between different socio-economic groups. For example, as presented in Section 2.4.2.1, Buliung and Kanaroglou (2002) conducted various computer simulations for different household compositions (e.g. for non-multi worker households or males in single-worker households with children under 15), and found that there is a difference in commuting by males and females. They showed that household structure affects distance of commuting conducted in the study area and that males have a greater potential for commute savings in terms of travel distance. Buliung and Kanaroglou (2002) concluded that a policy directed at a specific group of commuters has the power to reduce the commuting of that particular group.

Rodriguez (2004) introduced a concept of voluntary and involuntary excess commuting. He defined voluntary excess commuting as the level of commuting accepted by individuals as an exchange for other benefits e.g. access to local amenities or to non-work destinations, whereas involuntary excess commuting as additional level of commuting undertaken by individuals, who would like to reduce it, but are dissatisfied with the trade-offs required by their current residential and work locations. Rodriguez

(2004) highlighted that contextual factors constraining individual spatial choices influence the level of excess commuting. The author analysed over 300 responses from bank tellers in Bogota, Colombia. His results strongly suggested that if the two components of excess commuting (voluntary and involuntary excess commuting) could be taken into account in future calculations then excess commuting analysis would be more useful for transportation as well as for land-use policy. However, he does not show exactly how the two components could be included into calculations. Yang (2008) gave an example of "Live Near Your Work" policy applied in Baltimore, US, addressing the jobs-housing balance by subsidising the cost of home purchasing in the city in order to encourage homeownership and reduce unnecessary travel. However, he did not provide any evidence about how successful (or not) the implementation of the policy was and what impact it had on commuting patterns.

Ma and Banister (2006) stated that the importance of commuting trips decreases when the importance of non-work trips (e.g. leisure, school) increases. Therefore new policy should not be aimed at minimising the travel to work only. In line with Ma and Banister (2006), Fan *et al.* (2011) criticised the fact that the excess commuting literature excludes non-work trips, thus the implications of research are limited to just those policies related mainly to jobs-housing balances and improvements of accessibility between home and work (Horner and O'Kelly, 2007). In addition, the authors agreed with Scott et al. (1997) and Rodriguez (2004) that planners and policy-makers should not focus on spatially-related factors only (such as building density, land use mix, physical balance of jobs and homes) when addressing transport problems, but should consider some innovative policies. For example, Fan *et al.* (2011) suggested that policies leading to changes in existing areas in terms of, for example, school quality or neighbourhood security are priorities for reducing excess travel (Giuliano, 1995). If this approach is successful, according to Fan *et al.* (2011), no relocations are needed and the level of required and excess travel can be reduced, as people will travel to local destinations, which are offering good quality services.

Ma and Banister (2006) emphasised the fact that, although suggestions to policy makers have been made in the excess commuting literature, the results have not been used to support real policy decisions. They argued that the reason for this is hidden in various (often complicated and different) excess commuting calculations, as well as in the various contextual and methodological approaches used in the literature.

2.5 Summary

The aim of this study is to explore the characteristics of excess travel within commuting. The two different approaches to excess commuting as well as various issues concerning the phenomenon have been described and evaluated in the previous sections. Methodological issues concerning excess commuting research included challenges with: identifying geographical boundaries of a study area, using different measures (and parameters) for calculations and respecting urban spatial structure with jobs-housing (im)balances. These methodological issues have been found important when comparing studies from different cities or countries, as they influenced the final results that cannot be compared against results obtained in different places under different methodological conditions.

It has also been highlighted that in recent years more attention has been paid to exploring contextual issues including social, physical and psychological factors affecting travel behaviour. Psychological factors are particularly important as they play a key role in the positive utility of travel and hence play a critical role in whether one considers excess travel (commuting) is taking place or not. In recent years more authors admit that psychological factors are important in understanding behavioural content of commuting and have a role to play in excess commuting research. As stressed by a number of authors (Scott *et al.* (1997), Rodriguez (2004), Fan *et al.* (2011), Buliung and Kanaroglou (2002), Ma and Banister (2006)), a better understanding of physical, social and psychological factors influencing excess commuting and correlations between them is important as it could help to address new transport and travel behaviour issues (e.g. environmental issues).

The final issues related to policy-making highlighting the fact that, despite the potential of excess commuting to be used as a tool for influencing land use and transport planning policy, the variety of excess commuting methods employed and range of results and differing conclusions reached have acted as a barrier to policy makers. Although, suggestions such as improvements in school quality or neighbourhood security (Fan et al., 2011) have been made to policy makers, they were not related to transport itself but addressed societal challenges. Other authors (Buliung and Kanaroglou, (2002), Ma and Banister (2007)) suggested that policies targeting a particular group of commuters (e.g. broken down by occupation) could disadvantage other workers who are not targeted. Therefore an easy to apply and clear methodology for calculating and analysing excess

commuting is needed to allow clear interpretation of results and development of specific policies aimed at tackling specific societal challenges (e.g. smarter choices policies for green and sustainable transport).

It must be said that addressing all the above issues in one study is an enormous task, therefore this study identifies priority areas of understanding required in excess commuting research. These priority areas focus on contextual and methodological issues, where a number of selected factors need to be better understood. The most important issues, which require further investigation, are described in detail as research gaps in the next section below.

2.6 Research gaps

The previous three sections presented a review of the literature related to excess commuting phenomenon. Based on this review, four research gaps have been identified and are discussed in more detail in the next sub-sections.

2.6.1 A UK case study

Previous research on excess travel (commuting), as rightly pointed out by Murphy (2009), has focused mainly on US cities (Hamilton (1982), White (1988), Cropper and Gordon (1991), Small and Song (1992), Giuliano and Small (1993), Kim (1995), Song (1995), Horner (2002), Horner and Murray (2002), O'Kelly and Lee (2005), Yang (2008), Fan *et al.* (2011)). However, a few interesting studies presented results for Asian cities (Taipei – Chen (2000), Seoul – Ma and Banister (2006), Tokyo – Merriman et al. (1995), Japanese and Korean cities – Suzuki and Lee (2012)). There has been little published on excess commuting in European cities (exceptions include case studies of UK cities in Frost *et al.* (1998), Manning (2003), Polish cities in Niedzielski (2006) and Dublin in Murphy (2009)).

The US studies on excess commuting are car-oriented as 86% of commuting trips in the US are travelled by car and only 5% by public transport (McKenzie and Rapino, 2011). In Europe, and in the UK in particular, more diverse methods of commuting are available. The 2011 census conducted in England and Wales revealed that 60% of commuters use cars to get to work, 19% travel by public transport, 11% walk and 3% cycle (Office for National Statistics, 2013). A new European case study would enrich the existing literature and allow for more comparison between the studies conducted in

different worldwide locations and under different conditions. A new UK case study, where the public transport network is well developed, with buses and metro systems subsidised by local authorities, could add new perspectives to the excess travel literature. In addition, the UK heavily promotes public transport usage and large employers (e.g. universities and local authorities) are often involved in campaigns promoting smarter choices (e.g. "Cycle to Work Scheme" by Newcastle University; Newcastle University (2013)) and sustainable transport options (e.g. "Go Smarter" campaign in Tyne and Wear; Go Smarter (2013)).

2.6.2 Individual approach

This chapter showed that most of the excess commuting studies, especially in the US, focused on macro-level analyses (using for example large census datasets) at the zonal level and relied on housing and job locations (Fan *et al.*, 2011). As a consequence, previous studies of the excess commuting phenomenon have not addressed research questions relating to individual commuters (Rodriguez, 2004), which could provide new data as well as a new perspective for analyses. In addition, the specific employment-residential approach adopted in much of the excess commuting research makes it difficult to take into account individual and household limitations or local area characteristics (including spatial characteristics) which could contribute to a better understanding of the trade-offs between neighbourhood characteristics and travel efficiency (Fan *et al.*, 2011).

A primary travel-to-work data collection focussed on the residential-employment relationship and enriched with people's perceptions and opinions on their daily commuting is needed in order to examine the tendency for excess commuting to appear in calculations. Moreover, an investigation at the individual level can reveal if there are some characteristics common to those people performing excess travel (e.g. related to travel time or preferences and attitudes). This in turn can influence transport policy targeting different types of travellers (e.g. excess travellers and non-excess travellers) separately. Perhaps more importantly, from a methodological point of view, concentrating on the individual avoids MAUP issues.

As some authors have already noted, future research of excess commuting should not focus on jobs-housing balance only, but should integrate a more comprehensive set of characteristics at personal, housing and neighbourhood levels (Fan *et al.*, 2011).

2.6.3 Transport mode

One of the limitations of the majority of previous studies is that they have ignored the relationship between transport modes used for travel and the amount of excess travel performed by individuals. Some of the authors focused on one single transport mode in the context of excess travel (e.g. car in Hamilton (1982), King and Mast (1987) and Handy *et al.* (2005)). Only one study, by Murphy (2009), was found to compare public and private transport modes and its relationship in the light of excess commuting. Murphy (2009) shed some light on the relationship between the transport mode and excess commuting occurrence and found that it is more likely that public transport users will be classified as excess commuters. On a similar note, Ory and Mokhtarian (2009) who investigated individuals using both personal vehicles and bus for their travel, found that those who travel longer distance in personal vehicles perceive their travel to be greater, while individuals travelling more in a bus perceive their personal vehicle travel to be lower. In other words, there is a bias to an individual's perception of the amount he/she travels caused by the mode of transport used, and in the US context, travel by bus is perceived as an "unfulfilled opportunity" to use a car (Ory and Mokhtarian, 2009, p. 37). Despite this finding in the context of general travel, there is still little evidence on how various transport modes affects excess commuting performance.

In-depth analysis of individuals exhibiting excess travel and analysis of transport modes used could help to identify patterns (if any) between the amount of excess travel (this could be expressed by time, distance, cost or effort) and the use of specific public or private transport modes. If there is a relationship between excess travel and mode of travel used (for example if public transport users are more likely to act as excess travellers, as suggested by Murphy (2009)), this could lead to new policies targeting specific groups of travellers using specific modes of transport (e.g. policy addressed to drivers to switch to public transport or walking and cycling).

2.6.4 A clear methodology

As presented in the literature review most of the previous studies on excess commuting have focused on a quantitative analysis of the residential-employment imbalance (Hamilton (1982), Suzuki and Lee (2012)) or a qualitative analysis of individual factors responsible for excess travel phenomenon (Mokhtarian and Salomon (2001), Handy *et al.* (2005)). Ma and Banister (2006) admitted that it is difficult to identify the actual level of excess commuting that could be reduced, as the measures proposed in the

literature are not clear and excess commuting measures involve simplification (Fan *et al.*, 2011). Moreover, some authors admit that methods such as residential relocation exercise (Rodriguez, 2004; Fan *et al.,* 2011) or monocentric urban models (Hamilton, 1982) are theoretically possible, but in reality when used in excess commuting analysis might not be feasible due to organisational issues with regards to workers relocation and due to the presence of polycentric urban areas.

The variety of excess commuting measures leading to different results is one of the most important reasons why the results of the excess travel (commuting) research have not been used widely to support transport policy (Ma and Banister, 2004). This is related to both contextual and methodological issues described earlier (Sections 2.4.1 and 2.4.2). A transferable methodology needs to be employed that allows not only excess travel to be recognized, if present, but also allows both the quantitative and qualitative aspects of it to be recognised and understood. Understanding people's travel choices as well as measuring the parameters of excess travel (time, distance, cost, effort etc.) can help improve transport policy, as it responds to people's needs and expectations of travel itself, helping those experiencing negative utility transform to a positive utility of travel. Moreover, a proper understanding of an individual's choice of job or house can help to reduce worker's commuting time via developing an adequate policy (Ma and Banister, 2006). Thus, a clear, reliable and broadly applicable technique should be developed in order to produce results that are only specific to this study area, but the method could be applied to other areas in the UK and elsewhere.

2.7 Conclusions

The topic of excess commuting has been present in the travel behaviour literature since the 1980s and over the last 30 years, many authors have contributed to a much better understanding of this phenomenon. The contextual, methodological and policy-related issues all have their own role to play in evaluating excess commuting results. Today what is really important in understanding excess commuting, apart from the actual journey itself and its parameters, is the way decisions about commuting are made and the costs and benefits the actual journey brings to an individual. Answering the questions about who performs excess commuting (socio-economic characteristics of individuals, transport modes used), why they do it (psychological reasons, benefits), when and where excess commuting takes place (time and spatial location) and how to calculate it (methodology, equations and parameters) are crucial for building a

comprehensive picture of the excess commuting phenomenon. Thus methodology remains the weakest point of existing excess commuting studies as it is complicated and varies between the studies. This study therefore focuses on simplifying quantitative and qualitative methodologies for identifying excess commuting, which could be widely adopted. Travel attitudes and socio-economic characteristics will be also taken into account in evaluating the phenomenon.

Chapter 3. Methodology

3.1 Introduction

The aim of this chapter is to present the methodology that will address the four research gaps identified in Chapter 2 Section 2.6, to test this methodology in a pilot study and implement changes, based on this pilot study, to finalise the methodology for the main study. Section 3.2 introduces the three hypotheses of this study that relate to the relationship between commuters and potential excess commuting characteristics. These hypotheses draw on existing literature and are related to the identified research gaps. Section 3.3 focuses on the design of the data collection methodology employed in this study. Section 3.4 addresses the fourth research gap, which highlighted a need for a clear methodology for identifying excess commuting behaviour. Section 3.5 focuses on sample design of the study and addresses the first research gap, which suggested a new case study based in the UK is required. Section 3.6 explains the pilot study process, the lessons learnt for questionnaire design and the subsequent adjustment made for the main study.

3.2 Hypotheses

Travel choices depend on available transportation systems and socio-economic factors including characteristics of individuals, their households, journey purposes and attitudes towards travel (Williams (1978), Stradling (2006)). The hypotheses tested in this study, all linked to the research gaps described in Chapter 2, focus on the relationship between commuters and potential excess commuting characteristics. The first hypothesis (H1) is that:

H1: Excess commuters can be identified by their commuting behaviour.

The null hypothesis is that excess travellers cannot be identified by their commuting behaviour.

Excess commuting, as a type of travel behaviour, has been identified in the literature by using comparisons between the actual (time or distance) and the minimum (time or distance) commute (Hamilton, 1982; Ma and Banister, 2006). Authors used various definitions and calculation methods (see Chapter 2) to obtain results for excess commuting and all were based on the principle of comparing the actual behaviour with

modelled alternatives. Given that commuting is the most frequently performed journey, the anticipation is that excess commuters (EC) will be a small proportion of all commuters as most should be familiar with their commute route and the alternatives available, and thus choose optimal commuting solutions. Therefore it is hypothesized that excess commuters are different than non-excess commuters (NEC) in terms of travel characteristics (travel time, cost, distance, effort, etc.). However, as the literature review presented in Chapter 2 showed, EC identification is complicated, as many issues, including contextual and methodological, should be considered before EC and NEC are finally classified.

The second hypothesis (H2) investigated is:

> *H2: Travellers exhibiting excess travel in their commuting behaviour can be understood through socio-economic, lifestyle and travel attitudes.*

The null hypothesis is that travellers exhibiting excess commuting and non excess commuting cannot be understood through socio-economic, lifestyle and travel attitudes as these do not differ between the two groups.

H2 investigates the relationship between socio-economic and lifestyle characteristics of individuals and their daily travel attitudes and whether these factors can be used to understand the behaviour of excess commuters. The second hypothesis, as presented, suggests that excess travel applies to all trips, not to commute trips only, since exhibiting 'excess' within travel is as a result of non-trip factor such as, for example, age, household location in the city or "travel liking" (Redmond and Mokhtarian, 2001) attitude.

The second hypothesis suggests that factors such as personality, lifestyle, socio-economics or travel attitudes shape commuters in terms of their travel choices, but these factors also influence the benefits commuters derive from their journeys. In other words, different people with different personalities, different incomes, different households and different levels of access to transport options may exhibit different travel behaviours and receive different benefits from their commute (e.g. males tend to work further from home than females (Frost *et. al* (1998)); home-owners' excess commuting is larger than renters (Kim (1995))).

If excess commuting can be understood by analysing the relationships between commuters' socio-economic characteristics, lifestyles and attitudes this information can help public transport providers to develop potential strategies targeting this specific group of customers commuting 'more than necessary' without ignoring NEC. This could be achieved by using marketing strategies to attract additional excess commuters with services exploiting these non-travel attributes, where excess commuting could be presented as activity time highlighting extra benefits for both public transport users (e.g. switch on/off time before work) and providers (e.g. reductions in gas emissions).

The third hypothesis investigated (H3) is:

> *H3: There is a relationship between the different factors influencing travel choices and the propensity for excess commuting.*

The null hypothesis is that there is no relationship between the different factors influencing travel choices and the propensity for excess commuting.

The literature has not identified clear links between travel behaviour characteristics and the propensity for excess travel and this is investigated by the third hypothesis. This hypothesis investigates relationship between the factors related to the individual (e.g. one way commute time), which are influenced by factors which are unrelated (e.g. travel options). For example a one-way commute time may be affected by travel choices (the time one spends commuting may change by the options available). Other factors such as an ideal one-way commute time may be important and has been investigated by Mokhtarian and Salomon (2001), who showed that for their sample the ideal one-way commute was on average 16 minutes, but no comparison with actual time was presented. This hypothesis will therefore allow for the identification of factors leading to excess commuting that are not intrinsic to the person as in Hypothesis 2 and its importance lies in the potential prediction of people's perception for different travel choices (see e.g. Williams, 1978). Williams (1978) compared price and time characteristics of private and public transport and their effects on individual transport mode choice and concluded that walking time is important for choosing a transport mode for commuting trips, whereas walking and waiting times are important when selecting a mode for shopping trips. The current time spent on commuting may also affect the ideal one-way commuting time reported by the respondent (e.g. the more time

a respondent spends commuting daily, the more time he/she would probably accept as ideal one-way commute time). Also, for example, sources used to get travel information (e.g. public transport operator's website or timetables) will influence the knowledge commuters have about transport alternatives (e.g. the better access to transport information a respondent has, the better knowledge about transport alternatives that is available to him/her). This hypothesis is looking at factors that are not socio-economic driven, but can still contribute to a better understanding of excess commuting.

3.3 Design of a method for data collection

There are two main ways of gathering information about a research problem: from secondary sources (existing documents) or primary sources (observations, interviews or questionnaires) (Kumar, 2005). Both methods are used in this research, with secondary sources (earlier research, census data etc.) supporting the sample selection process (see Section 3.4), while primary sources are used to collect data about travel behaviour. This section describes the questionnaire design used to extract information from respondents on how travel attitudes, preferences, home and work location and socio-economic backgrounds influence their travel choices in order to analyse if any excess commuting occurs in the sample and if so to try and explain its reasons.

3.3.1 Choice of a method for data collection

A questionnaire method was selected as the best way to collect travel behaviour data as it best suits the research hypotheses presented earlier. Other methods, such as individual and focus group interviews, telephone interviews or observations were considered but rejected. Whilst the nature of focus groups allows the collection of detailed data about individual participants, they also provoke interactions and spontaneous 'questions and answers' or discussions in a group (Kumar, 2005). The group effect means that anonymity is lost and a person might not be willing to share his/her opinions openly (Kumar, 2005). Therefore this method was rejected, as it is important for the study to collect honest and well-thought-through opinions related to an individual's travel behaviour.

Individual interviews are a time consuming method, targeting a small number of participants. This method was rejected, as it is important for the study to collect a large sample since it is anticipated that excess commuters may form a small proportion of the commuting population (Table 2.1 in Chapter 2 presented results for mean excess time

between 11% and 78%). A large sample is moreover needed to undertake statistical testing between EC and NEC (e.g. a sample size of over 300 is recommended by Field (2009) for statistical factor analysis). Telephone interviews were rejected as they are time and cost consuming and difficult to arrange as available secondary sources of names and addresses, such as electoral roles, do not give telephone numbers and the use of telephone listings would give rise to bias as not all residents have telephones and not all telephone account holders are listed.

The observation method was rejected as not being appropriate to this research, since socio-economic data were required to test hypotheses, and this would be difficult to collect from people not directly involved in the study. Moreover, this study requires information on individuals' perceptions to travel and these cannot be collected using this method. In addition, this method is prone to bias because, as Kumar (2005) noted, after individuals realise that they are being observed they may simply stop their typical travel behaviour.

The choice of a questionnaire approach allows the inclusion of a larger number of individuals commuting on a daily basis to be surveyed while keeping the study realistic in terms of budget and survey time. Questionnaires can be delivered to home addresses or be distributed at work in hard copies or made available online. As the aim of this study is to explore the characteristics of excess commuting as well as to quantify the phenomenon, a larger sample size is preferred over a small one. Other advantages to the choice of a questionnaire methodology include efficient sample collection (large samples possible in a relatively short period of time (time required for questionnaire design, distribution and collection) and with limited financial resources (printing and stamp costs only, no additional staff cost)). In addition, this method guarantees anonymity and flexibility (in terms of time for completion by respondents), which is important when asking attitudinal questions in particular.

Although the questionnaire method was selected as best for this study, some limitations exist with this approach. Kumar (2005) noted that a questionnaire is limited to respondents that are literate. Moreover, response rates are often only between 20-50% (this depends on various factors and incentives; see e.g. Larson and Chow (2003), Mokhtarian and Salomon (2001)) and may not be representative of the entire population

being sampled. In addition, there is little opportunity to clarify the meaning of responses or to understand exogenous influences of the response to questions (Kumar, 2005).

3.3.2 Questionnaire design and mapping questions to hypotheses

The main content of the questionnaire developed in this study was influenced by the work of Redmond and Mokhtarian, (2001), Mokhtarian and Salomon (2001), Ory and Mokhtarian (2004) who undertook a detailed questionnaire of travel attitudes of residents in the San Francisco Bay Area, US and provided a tested framework of attitudinal questions (see Table 3.2).

Questionnaire design principles (Dunn *et al.*, 2003; Murray, 1999) indicate that the order of questions is of paramount importance. It is recommended that questionnaires start with simple closed questions (Dunn *et al.*, 2003) and that questions focusing on a similar subject are grouped together for consistency, and that there is a coherent logical flow from one theme to another (Murray, 1999). This meant that the information to analyse the second and the third hypothesis was spread throughout the questionnaire as a result of grouping questions about respondents' daily commute and their personal demographics. The questionnaire was split into four parts, to give the questionnaire a logical structure and make it respondent friendly. The structure of the questionnaire was designed to capture the most recent data first (part one: daily travel behaviour), then preferences regarding attitudinal statements (part two: opinions/preferences) followed by information on home and work locations and distance travelled (part three: geographical data) and finally a section for personal details (part four: socio-economic data).

3.3.2.1 Part one – daily travel

Part one of the questionnaire focuses on daily travel behaviour. Respondents were asked about their most recent travel first as it was expected this would be very familiar and easy for them to answer. The questions were designed to capture information relevant to answering the second and third hypotheses and, where it was appropriate, questions were framed in a way to be compatible for comparison with the travel behaviour questionnaires of Mokhtarian *et al.* (2001) and Aditjandra (2008). Mokhtarian *et al.* (2001) and Aditjandra (2008) both asked respondents questions relating to their daily travel routine (frequency, time, mode, etc.). However the main focus of their surveys

was on attitudes towards travel. Table 3.1 identifies the questions used in part one of the questionnaire and the way they relate to the second and the third hypothesis.

Question	Hypothesis
Frequency of travel to work	H2
Usual transport mode to work	H2
Description of the last journey from home to work	H2
Description of alternatives transport modes and reasons why they were not selected	H3
Actual time and cost of single journey from home to work	H3
Activities conducted when commuting	H2

Table 3.1 The questions in part one of the questionnaire and the related hypothesis.

Most questions are closed and require "tick box" responses only. Two questions are open and ask respondents for a step-by-step description of the last journey to work and alternative transport modes (if available), and the reasons why these alternative modes were not used. This links directly to the hypotheses to identify excess commuters and the underlying factors that might identify the causes of excess travelling (H3). The question asking about actual time and cost of the journey from home to work is recording self-reported, perceived values of these two parameters, not the actual values. The self-reported values will be verified against time and cost calculations based on origin and destination locations, which are self-reported in part four of the questionnaire.

3.3.2.2 Part two – attitudinal statements towards commuting

Part two of the questionnaire includes attitudinal statements (e.g. "I like to travel more just for fun") and the importance of different variables when choosing travel options (e.g. curiosity of new places). Answer options in questionnaires can be presented visually on a scale with a 5 to 7 category Likert scale often suggested for attitudinal and personality statements (Fowler (1995), Mokhtarian and Salomon (2001), Prillwitz and Barr (2012), Stillwater *et al.* (2012)). However, some studies have successfully used a 4-point Likert scale to investigate various travel behaviour issues (Barker and Page (2002), Johansson (2006), Aditjandra (2008), Lois and Lopez-Saez (2009), Egbue and Log (2012)). In general, a 4-point scale forces a respondent to make a decision when answering a question, while a 5-point scale gives a midpoint option that can be interpreted as a neutral response (Dillman (2006), Goddard and Melville (2001)). This study uses 4- as well as 5-point Likert scales to keep the questionnaire fairly simple.

This part of the questionnaire is targeted at providing information for H2 and provides information on the benefits (if any) that respondents derive from their daily commute. The variables describing attitude factors used in the Redmond (2000; cited in Mokhtarian *et al.* (2001) and other related studies (e.g. Salomon and Mokhtarian (1998), Mokhtarian and Salomon (2001), Ory and Mokhtarian (2004), Ory and Mokhtarian (2005)) looking at attitudes in the excess travel inspired the design of this part of the questionnaire. However, as this study concentrates on commuters and is UK based, questions had to be adapted to keep the questionnaire statements in the first person form as shown in Table 3.2. As with Redmond's study (Redmond (2000) cited in Mokhtarian *et al.* (2001)), respondents are asked to rate each statement on a 4-point scale, from "not at all true" to "very true".

The questions presented in Table 3.2 are broadly divided into three parts related to enjoyment, negative experiences of travel and policy issues for the convenience of making the questionnaire more accessible. Whilst this study is focusing on public transport, the questionnaire seeks to identify whether commuting by car is an immutable feature of the respondent's travel behaviour since this is an important factor in determining the impact of attitudes on travel behaviour (e.g. value of driving itself in Handy *et al.* (2005)). Four questions shown in the top four rows in Table 3.3 are designed to target car drivers only with an aim to elicit information about a respondent's driving behaviour and to contribute to a better understanding of respondents' personality.

H1 considers the importance of different non-travel characteristics to the respondents travel choice. Further questions ask respondents to rate on a five-point scale (from 1 – "not important" to 5 – "very important") the importance of nine specific variables when choosing their commuting travel options. The 5-point scale is used here as it was important for respondents to be able to signal a neutral response. These are listed in Table 3.3.

Source	Original attitude factors	Attitude factors adopted to Tyne and Wear study	Type
1	How often do you travel by a longer route to experience more of your surroundings?	Sometimes I choose another route because I'm curious of the new route	Enjoyment
1	How often do you travel out of your way to see beautiful scenery?	When I travel I have a chance to enjoy scenic beauty	
1	How often do you travel just to relax?	A travel time is a good time to relax	
1	How often do you travel when you need time to think?	A travel time is a good time to think	
1	How often do you travel to clear your head?	A travel time is a good time to clear my head	
1	How often do you travel mainly to be alone?	A travel time is a good way to be alone	
3	How often do you travel just for the fun of it?	I like to travel more just for the fun	
3	It is common to use travel to temporarily escape obligations, routines, and/or tensions at home or work	For me longer travel is an escape	
5	Under some circumstances, *travel* is desired for its own *sake*	I like to travel for travel's sake	
2	I like exploring new places	I like exploring new places	
2	Getting there is half the fun	Getting there is half the fun	
2	My commute is a useful transition between home and work	My trip is a useful transition between home and work/destination	
2	I like travelling alone	I like travelling alone	
2	Travel time is generally wasted time	I think my travel time is wasted	Negative
2	I use my commute time productively	I think I could use my travel time more productively	
2	Travelling is boring	I think travel is boring	
2	The only good thing about travelling is arriving at your destination	The only good thing about travelling is arriving at your destination	
2	My commute is a real hassle	My trip is a real hassle	
2	I am uncomfortable being around people I don't know when I travel	I am uncomfortable being around people I don't know when I travel	
2	We need more public transportation, even if taxes have to pay for a lot of the costs	We need more public transportation, even if taxes have to pay for a lot of the costs	Policy
2	To improve air quality, I am willing to pay a little more to use an electric or other clean-fuel vehicle	I think about climate change/other environmental issues when making travel choices	
4	Travelling "in style" (e.g. in a luxury car) can be a symbol of a desired socio-economic class or lifestyle	I feel proud of owning a vehicle	

Table 3.2 Attitude factors adapted from Redmond (2000; cited in Mokhtarian *et al.*, 2001). Source: 1. Ory and Mokhtarian (2004), 2. Redmond (2000; cited in Mokhtarian *et al.* (2001)), 3. Ory and Mokhtarian (2005), 4. Salomon and Mokhtarian (1998), 5. Mokhtarian and Salomon (2001).

This part of the questionnaire includes questions on attitudinal factors that relate specifically to commuting and are not comparable with previous studies (e.g. teleportation phenomenon or ideal one-way commute time). One question in particular focuses on the respondents' flexibility in changing transport modes and potential benefits of the commute – the teleportation test. The teleportation test, is an important issue for this research because if a respondent prefers to teleport due to for example time savings, the benefits of traditional travel in terms of 'escape' or 'buffer' time are limited and voluntary excess commuting in respondent's behaviour is unlikely to occur. The 'teleportation' question included in the questionnaire is adapted from the original question from Mokhtarian and Salomon (2001, p. 711):

> *"If you could snap your fingers and blink your eyes and instantaneously teleport yourself to the desired destination, would you do so?"*

The final version of the statement used in the questionnaire was:

> *If you could arrive at your work without commuting would you like to do it? (e.g. if you could use teleportation phenomenon like in "Star Trek" –science fiction film; teleportation is the movement of objects from one place to another without travelling through the space).*

Overall, the majority of questions in this part of the questionnaire address H2 by asking about driving behaviour/personality, characteristics of travel choice and importance of various factors as well as commuting activities, mode switch and advice for public transport operators for improving the offer. H3 was addressed in a number of questions relating to attitudes towards actual and ideal commuting options, sources of information about local transport options and travel initiatives promoting sustainable commuting (e.g. car clubs). The questions included in the second part of the questionnaire and the hypotheses they address are shown in Table 3.3.

Purpose	Question	Hypothesis
Driving behaviour/ Personality	I'm driving because there are more of us in a car	H2
	If I could find a quicker and cheaper way I would use it	H2
	I like to feel the sensation of speed when I'm driving	H2
	I enjoy driving because I've got a good car	H2
Characteristics of travel choice (how important these factors are)	Good accessibility	H2
	Good comfort	H2
	Curiosity of new places	H2
	Short distance	H2
	High independence	H2
	Low price	H2
	Good safety	H2
	Short time	H2
	Good enjoyment	H2
Knowledge about and attitudes towards commuting in terms of:	The amount of time spend commuting	H3
	Ideal one-way commute time (please specify the time)	H3
	Types of activities conducted when commuting	H2
	Teleportation phenomenon (like or dislike, why?)	H2
	Mode switching and reasons behind	H2
	Sources of information about local transport options	H3
	Types of known travel initiatives promoting sustainable solutions (e.g. car clubs, workplace travel plans)	H3
	Advice for public transport operators to improve the transportation system	H2

Table 3.3 Links between questions, purposes and hypothesis used in section two of the questionnaire.

3.3.2.3 Part three – geographical data

Identification of excess commuting requires geographical knowledge such as location data relating to commuting (see e.g. Buliung and Kanaroglou (2002), Fan *et al.* (2011)). To identify alternative transport options for each respondent requires the details of origin (home) and subsequent destination (work). With information about the postcodes of origin and destination in combination with online transport tools (e.g. Google Maps, Transport Direct website), the alternative travel routes, times, costs and efforts can be calculated in the analysis.

This section of questions is linked mainly to H3, which considers the impact respondent's knowledge of local transport options have on their perception and use of alternatives. Such knowledge about public transport services (e.g. timetables) may act as a factor influencing respondents' travel choices and as a result may have an impact on their propensity for excess travel.

Alongside factual questions about origin and destination postcodes, additional questions were asked to find out what respondents' think about their local transport options and what options they know exist in their area. These questions consider geography more generally compared to the precise request for postcodes; for example whether the respondent lives in a rural or urban setting.

Other questions in this section also request information from respondents on their perception of the 'quality' of the transport provision in their area; such as the level of transport infrastructure (road conditions, transport links etc.), and transport accessibility (bus frequency, access to public transport). These questions are recorded using a five-point scale, from 1 – "very poor" to 5 – "excellent", as well as an open box for additional comments and address H2 of the study related to attitudinal questions.

3.3.2.4 Part four – socio-economic characteristics

The final part of the questionnaire is designed to capture the socio-economic characteristics of respondents, as required by H2. In particular, census characteristics of gender and age of residents as well as household structure will help in future comparisons of the sample against census results in areas surveyed. The key socio-economic characteristics identified in the literature (see e.g. Kim (1995), Mokhtarian *et. al* (2001), Fan *et al.* (2011)) are requested using the categorisation used in England and Wales 2001 census, so as to provide a basis on which to measure the characteristics of the sample relative to the population (Table 3.4).

No.	Variable	Answer options				
1	Gender	Male			Female	
2	Age	23 or younger	24-40	41-64	56-74	75 or older
3	Marital status	Single	Married or re-married	Separated or divorced	Widowed	
4	Economic activity	(see Table 3.5)				
5	Number of people living in household	1 person	2 people	3 people	4 people	5 or more people
6	Driving license	Yes		No		
7	Number of cars or vans in the household	None	One	Two	Three	Four or more
8	Time period lived at current address	Months/Years				
9	Place moved from	Elsewhere in the North East	Elsewhere in the UK	Elsewhere abroad		
10	Reason why moved into the current area	(open question)				
11	Time period employed in the current job	Months/Years				

Table 3.4 Socio-economic variables used in the questionnaire.

The socio-economic questions are structured such that they allow the respondents to provide the information required for the analysis of this study without asking for details that may be considered sensitive. For example, Table 3.4 does not include a question on

income since this is often perceived as a sensitive piece of information by individuals (Kumar, 2005). Instead, employment status, based on The National Statistics Socio-economic Classification (NS-SEC), is used as a proxy (see e.g. Rose and Pevalin (2003)). The NS-SEC classification is occupationally based, and important for testing H2, because it helps to estimate respondents' income without directly asking for it. Whilst the census classification (see Table 3.5) includes 17 categories, the questionnaire reduces this number to seven economic activity options, which are expected to be correlated with income. The final question of this section provides tick box options for part-time, full-time or self-employed respondents, which again is anticipated to correlate with income.

Original The National Statistics Socio-economic Classification	Economic activity classification adopted for the pilot study
L1 Employers in large organisations L2 Higher managerial occupations L3 Higher professional occupations	Higher Managerial and Professional (e.g. employers in large organisations, managerial occupations)
L4 Lower professional and higher technical occupations L5 Lower managerial occupations	Lower Managerial and Professional
L6 Higher supervisory occupations L7 Intermediate occupations L8 Employers in small organisations L9 Own account workers L10 Lower supervisory occupations L11 Lower technical occupations	Supervisor, production worker, skilled trade (or similar)
L12 Semi-routine occupations L13 Routine occupations	Clerical, retail staff (or other routine)
L14 Never worked and long-term unemployed	Never worked and long-term unemployed
L15 Full-time students	Student
L16 Occupations not stated or inadequately described L17 Not classifiable for other reasons	Occupations not stated or inadequately described

Table 3.5 Socio-economic classification adapted from The Office for National Statistics. Source: Office for National Statistics (2011) and this study.

3.3.3 Survey delivery methods

The questionnaire could be delivered as a paper version or made available on-line; the relative advantages and disadvantages of which for this study have been explored in Fraszczyk and Mulley (2014). The following two sub-sections present details of the two delivery methods employed for the questionnaire.

3.3.3.1 Paper based delivery to respondent's home

A paper based questionnaire, should be pleasant to the eye and have an interactive style where questions are easy to understand and complete (Kumar (2005), Murray (1999)). The questionnaire was designed as an A5 size booklet with 8 pages, where the cover and the last page explain the aims of the survey and the six pages inside, with thirty six questions, are for respondents to complete. The contact details of the researcher, school address and email address, and a space for additional comments are included in the questionnaire. The questionnaire can be seen in Appendix B.

Research conducted by Ray and Still (1987) concluded that a preliminary letter, reminder letters and other enhancement techniques can nearly double the response rates from 25% to 47% when using a paper based questionnaire. This research used covering and reminder letters in an attempt to achieve the highest possible response rate. A covering letter explaining the purpose of the study, its main objectives, the choice of home/workplace selection and the contact details of the researcher was included in each questionnaire delivered. The covering letter is at D. A reminder card was designed for delivery two weeks after the questionnaire to remind potential respondents about the deadline for completion. The reminder card included information about the survey and the research project (Appendix E).

3.3.3.2 Online workplace questionnaire

An online version of the questionnaire was created using the commercial website www.smart-survey.co.uk to publish the questionnaire on the Internet. The paper and online versions of the questionnaire were identical. A covering email was sent to potential respondents along with information on the URL of the survey website (Appendix C). Respondents were given two weeks to complete the online questionnaire. After this period the survey was closed for new entries.

3.3.4 Incentive

Both monetary (e.g. cash or gift vouchers) and non-monetary (e.g. pen or fridge magnet) incentives have been found to increase response rates in surveys (Larsen and Chow (2003)). In addition, an incentive demonstrates that respondent's time is appreciated. Some research shows that monetary incentives are more effective in increasing return rates (Tooley (1996), Edwards *et al.* (2002)), but obviously the total costs of these surveys are greater (see Larsen and Chow (2003)).

This study recognises that it requires the respondents to give their time (approx. 20 minutes) to answer the questionnaire. However, the budget for the study is limited and it was decided to use a non-monetary and relatively inexpensive incentive. To test the methodology an individually wrapped tea bag was added to each envelope along with the paper questionnaire and the cover letter. The letter encouraged a potential respondent to relax, make a cup of tea and complete the survey. Teabags for the envelopes study included purchased "Twinnings" herbal teas and "English Breakfast" teabags sponsored by "Cooper & Co" (www.cooper.co.je).

3.4 Design of a method for measuring excess commuting

The research gaps presented in Chapter 2 Section 2.6 highlighted that there is a need for a simplified methodology for identifying excess commuting and its magnitude in the population (see Section 2.6.4), as well as being able to understand excess commuting on an individual basis (see Section 2.6.2). Two different methods, based on detailed information on time, cost, effort of travel between origin (home) and destination (work), are considered for testing the existence and magnitude of excess commuting.

The first method for identifying excess commuting behaviour is based on "pure" results reported by respondents where excess commuters (EC) are considered from three perspectives: travel time, monetary cost and overall effort. The second method for identifying excess commuting behaviour adopts a more structured and widely used 'generalised cost' method and uses a mathematical formula to calculate generalised cost for self-reported journey and the alternatives.

The pure travel time, pure monetary costs and results for pure effort of self-reported (SR) journeys are compared with pure results for four new alternatives. The four alternatives are: a car journey (OPT1), two public transport options (OPT2 and OPT3) and one walking option (OPT4). Similarly, generalised cost results for the SR journey are compared with the four alternatives. Both methods are described in detail below.

3.4.1 Pure time, cost and effort

In the pure time and cost approach the absolute value of the self-reported values are used for the time, distance, cost and effort of the commute. The two parameters of time and cost are relatively easy to self-report, as commuters are expected to know how much time their commuting takes (see e.g. Handy *et al.* (2005)) and how much it costs

them (see e.g. Tse and Chan (2003)). The distance parameter is verified using the self-reported origin and destination postcodes (or addresses). The absolute effort involved in the commute is approximated from the descriptive responses to a question in the questionnaire, which asks for detailed step-by-step description of the last journey from home to work, including all times (e.g. walking, waiting time), interchanges and all modes of transport used.

Excess commuting, as defined simply in Section 3.2, is the difference between the actual (in this case SR) and the minimum commute. When alternative travel options provide some defined savings, in terms of time travelled, monetary cost or effort required, over the self-reported option, the self-reported option is considered as excessive. As the establishment of alternative times could be optimistic, sensitivity analysis of establishing an excess commuter are applied. The sensitivity analysis includes 5%, 10%, 15%, 20%, 30%, 40% and 50% or more above the minimum value of time and cost parameters for each alternative travel option.

In the analysis (see Chapter 4) the self-reported (SR) times and costs of travel (both 'pure' using the absolute value or calculated using generalised cost) are compared with times and costs of public transport options (PTOs) for the same origin-destination pairs, with the prices for the PTOs derived first on the basis of an annual ticket and second on the cost of a daily ticket. The analysis therefore required the questionnaire to seek detailed information on time taken and monetary cost incurred and enough information in order to obtain an estimate of effort.

3.4.1.1 Pure time

The four alternative transport options are examined in terms of travel time. For OPT1 the actual monetary cost is sourced from the Transport Direct portal (www.transportdirect.info) as running costs and fuel and for other ticket price options are with local public transport operators' sites. Actual times are calculated using Google Maps (www.maps.google.co.uk) and the Transport Direct, although the tools used for driving time calculations do not include actual waiting times, congestion (timetables for public transport options take into account the above), road works, weather conditions, etc., therefore overall it is expected that time results for OPT1 are ideal-estimates rather than real-life-scenarios. Monetary costs for self-reported walking and cycling and walking for OPT4 are classified as £0.

Recent evidence from the literature suggests that for drivers perceived commute is greater than actual travel time due to e.g. reporting errors (Peer *et al.*, 2013)). Therefore the data is carefully verified as the questionnaire asks the question about travel time twice, but in different context (see Appendix B).

3.4.1.2 Cost excess commuters

In this study, for the option of a car journey, the pure monetary cost is calculated as a fuel cost plus running cost, both sourced from Transport Direct (Transport Direct includes these two elements only, see Appendix J). Parking cost is not considered, as no specific data related to parking availability or prices are collected.

To calculate the costs of the two alternative options by public transport four main local public transport providers' websites are used: Stagecoach (www.stagecoachbus.com), Go North East (www.simplygo.com), Arriva (www.arrivabus.co.uk) – for bus ticket prices and Nexus (www.nexus.og.uk) for metro ticket prices. A single journey price is calculated as the annual ticket price (prices for 2010 when the survey took place) divided by 222 working days for employees (365 days in a year minus weekends minus bank holidays & holidays) divided by two journeys a day (to and from work). For example, the price of a Stagecoach Annual Mega Rider is £509/222 working days/2 journeys a day = £1.15 for a single journey.

3.4.1.3 Effort excess commuters

The three-type effort classification (with physical, cognitive and affective effort) proposed by Stradling (2006), has been used as the foundation for the effort analysis. The self-reported options have been compared against the four proposed transport options. It is assumed that people will have the same origin and destination points (postcodes) for self-reported as well as for the alternative travel mode options and in this context an effort factor linked to excess commute is tested. Table 3.6 shows a simple technique, based on Stradling (2006), used for effort analysis and comparisons between options.

Type of effort	Question related to	Answer options for alternative journey in relation to self-reported journey	Scores
Physical	Walking time	Less or Equal	0
		More	1
	Waiting time	Less or Equal	0
		More	1
	In vehicle time	Less or Equal	0
		More	1
	Interchanges	Less or Equal	0
		More	1
Cognitive	Mode	Same	0
		Different	1
	Route	Same	0
		Different	1
Affective	Transport mode	Car, walk	0
		Public transport	1

Table 3.6 Scoring system for pure effort analysis.

Pure effort has three components described as: physical, cognitive and affective, as presented in Table 3.6. Physical effort has four components: walking time, waiting time, in-vehicle time and interchanges, and scores are awarded when the values (minutes for the first three items and numbers in the case of interchanges) for alternatives are greater than for self-reported travel. Physical effort is calculated as the sum of effort in terms of walking time, waiting time, in-vehicle time and number of interchanges.

Cognitive effort is based on two elements: mode and route, where scores are awarded when those are different in an alternative option than those self-reported. It is assumed that using a new mode of transport and following a new route require cognitive effort (give example here) from a respondent to become familiar with the different way of making their journey to work. Cognitive effort is calculated on the basis that more effort is needed to switch between modes than to stay with an existing regularly used mode. For example respondent number 52 is currently using a car and a new car option would not require a large amount of advanced planning (mode, route etc.). However, if the same respondent wants to switch from a car to a public transport option, then there is more effort required to familiarise themselves with the new journey and route in advance, as the assumption is that drivers have little or no knowledge of the public transport options as they do not use them.

The affective scoring system is based on Stradling (2002) claims that in general people using cars are spending less emotional energy (affective effort) on a journey dealing with "uncertainty about safe and comfortable travel and timely arrival at final destination" (Stradling, 2002, p. 23). Walking was added to this category as it is

assumed that people who self-reported these options are familiar with journey routes used and there is no additional affective effort spend on their journeys.

Affective effort in this study is focused on the two main fears of being late for work and personal safety (Stradling, 2002). As stated earlier, Stradling (2002) suggested that car users spend less emotional energy on a journey than public transport users. It is assumed that people using public transport are at risk of worrying about being late for work or their personal safety more than car users or walkers, who can control and influence their travel parameters. This means that the emotional effort needed to use PT alternatives would be greater than using a car or walking option. Based on the above statements, calculations for affective effort are made for OPT1 (car) only, as the next two alternatives employs PT (and according to Stradling (2002) public transport would require more affective effort anyway).

3.4.2 Generalised cost

The second alternative uses a generalised cost definition to compare SR travel and the proposed PTOs. This is based on the methodology outlined by the UK Department for Transport (2009) where separate equations for calculating generalised cost for journeys made by car and public transport are recommended. The generalised cost formula for public transport is:

$$G_{PT} = V_{WALK} \cdot A + V_{WAIT} \cdot W + T + \frac{F}{VOT} + I \qquad \text{Eq. 3.1}$$

Where A [minutes] is the total walking time to and from the service, W [minutes] is the total waiting time for all services used on the journey, T [minutes] is time spent on the service (bus, train), F [British pounds] is the fare and I [minutes] the interchange penalty. Values for I vary between 0-10 minutes. V_{WALK} and V_{WAIT} are weights for walking and waiting, with values 1-2 and 1-2.5 respectively. VOT [British pounds/hour] is a value of time for a non-working time and is specified by Department for Transport as £5.04/h (Department for Transport, 2009). This approach, used regularly in transport evaluation, uses empirically determined weights for the different elements of the journey. However, it must be noted that the suggested weights and income figures have stayed unchanged since 2002, which raises an issue over their reliability, particularly in regard to the income figures and is a further reason why sensitivity analysis is undertaken. Further sensitivity analysis is undertaken to vary the values for the weights V_{WALK} and V_{WAIT}. Table 3.7 presents 13 weights' options for walking, waiting and

interchanges, where values for each option are different. Generalised cost calculations for the SR journey and the alternatives are repeated 13 times using different options and results for each alternative are compared (generalised cost for OPT4 – walking is not applicable as its monetary cost is classified as £0).

Option number	Weight for walking (V_{WALK})	Weight for waiting (V_{WAIT})	Weight for interchanges (I)
1	1	1	0
2	2	2.5	10
3	1.5	2	5
4	1.5	1.5	5
5	2	1.5	5
6	1.5	1.5	10
7	1.5	2	10
8	2	1.5	10
9	2	2	5
10	2	2	10
11	1.5	2.5	5
12	2	2.5	5
13	1.5	2.5	10

Table 3.7 13 weights' options for walking, waiting and interchange parameters used in the generalised cost calculations

The generalised cost formula for car journeys is:

$$G_{CAR} = V_{WALK} \cdot A + T + \frac{D \cdot VOC}{occ \cdot VOT} + \frac{PC}{occ \cdot VOT} \qquad \text{Eq. 3.2}$$

Where D [km] is the total distance travelled, VOC [pence per km] is a vehicle operating cost, occ [count] is occupancy of the vehicle, and PC [British pounds] is a parking cost. All elements of physical effort, as identified by Stradling (2006, 2011), such as walking and waiting times and interchanges, are included in the generalised cost formula. It must be noted, however, that this method does not offer equivalents for pure cognitive or affective efforts, as there are no elements of mental effort (e.g. journey planning) or emotional effort (e.g. stress associated with the journey) in the generalised cost formula. Therefore a full comparison of the results achieved using the two methods ('pure' and generalised cost) is limited. Although, as identified above, the pure and generalised cost methods put emphasis on different variables, the final number of individuals identified as EC within the sub-groups (time EC, cost EC, effort EC and generalised cost EC) will be compared to show the scale of EC phenomena when taking into account single parameters versus the generalised cost formula. This identification forms the fulfilment of Hypothesis 1 and provides the basis for investigating Hypotheses 2 and 3.

3.5 Sampling process

The sampling process described in this section includes a consideration of the required criterion for the selection of a study area, the use of GIS as a tool for the selection of

origin (home) and destination (work) sample areas. As described above, this study requires geographical information (e.g. postcodes, maps) to identify the journeys undertaken by respondents when travelling between home and work. England and Wales 2001 Census data was used to identify sample 'hotspots' meaning selected areas meeting certain 'travel to work' and socio-economic criteria in the sample selection.

3.5.1 The choice of Tyne and Wear as a case study area

The Tyne and Wear region was selected as the case study area for a number of reasons: the size of the region, its transport infrastructure and its representativeness of a UK metropolitan area outside the capital, London. The three criteria are described is this section.

The Tyne and Wear region is located in the North East of England (Figure 3.1) and comprises of five local authorities: Newcastle upon Tyne, Gateshead, North Tyneside, South Tyneside and Sunderland. The total population, according to 2001 census, was 1,075,935 (TWRI, 2004). To examine how representative the Tyne and Wear region is of a large metropolitan conurbation, in terms of its public transport infrastructure but also in terms of its transport plans, a comparison between Tyne and Wear and two other similar sized metropolitan areas: Greater Manchester and West Midlands was performed.

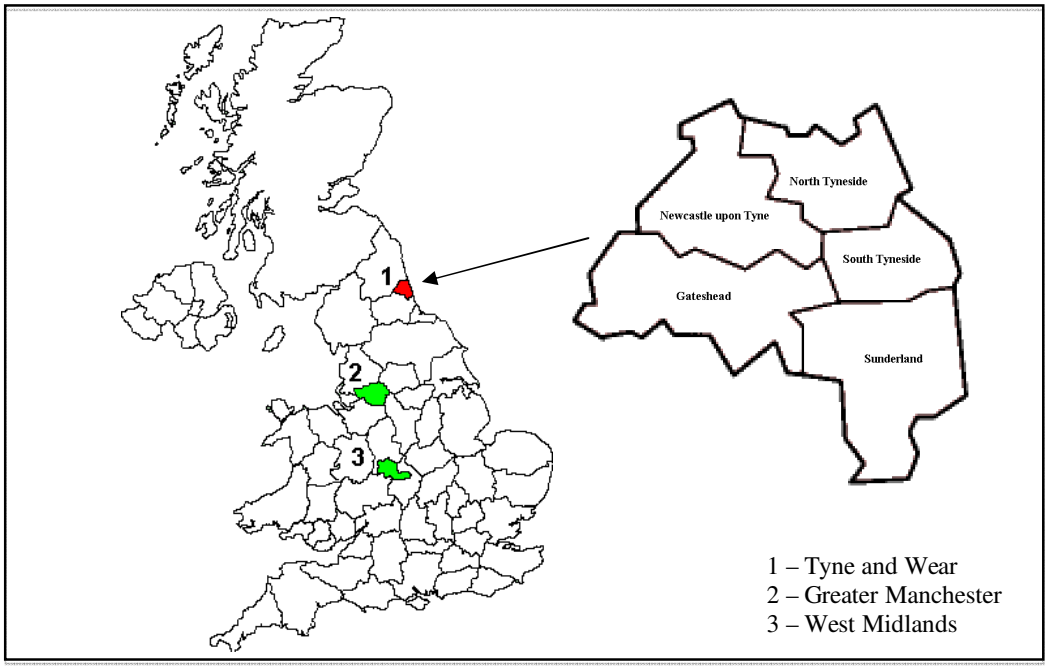


Figure 3.1 Picture of the UK and its counties with highlighted location of the three metropolitan areas: 1 - Tyne and Wear County (five local authorities enlarged on the right), 2 - Greater Manchester, 3 - West Midlands. Source: www.badc.nerc.ac.uk

The three metropolitan areas highlighted in Figure 3.1 have Local Transport Plans (LTPs) that describe transport strategies for the region (5-years strategy in Greater Manchester, 10-years in Tyne and Wear and 15-years in the case of the West Midlands). The England and Wales Census 2001 data were used to compare the three regional populations in terms of: gender, percentage of employed population, number of households with cars and travel to work characteristics (Table 3.8). Although the total population in Tyne and Wear was half of Greater Manchester (population of 2.5 million (ONS, 2013))) and a fifth of West Midlands (population of 5.3 million (ONS, 2013)), the gender balance and proportion of employed people had comparable values. The main differences between the areas were that Tyne and Wear had a higher proportion of households with no car/van (42% compared to 33% in Greater Manchester and 27% in West Midlands). As a consequence, less people drove to work (59% in Tyne and Wear; 6% and 8% less than in Greater Manchester and the West Midlands respectively). Therefore, a greater proportion of people in Tyne and Wear use public transport for commuting (21% compared to 13% in Greater Manchester and 10% in West Midlands).

Census 2001 question	**Tyne and Wear [%]**	**Greater Manchester [%]**	**West Midlands [%]**
Households with no car/van [%]	42	33	27
Travel to work by car [%]	59	65	67
Travel to work by public transport [%]	21	13	10
Males	48	49	49
Females	52	51	51
Employed	53	58	60
Total population [count]	1,075,938	2,482,328	5,267,000

Table 3.8 Census 2001 figures for three metropolitan areas in England. Source: England and Wales 2001 census

Table 3.8 show that Tyne and Wear is similar to the other conurbations outside the capital city, London, albeit with slightly different mode split in the journey to work. However, Tyne and Wear has a smaller population and it is not clear how successful the new LTP strategies, started in 2011, will be in influencing the use of mode split tools like ‘smarter choices’ (e.g. www.gosmarter.co.uk website with information about smarter travel options), travel plans and car clubs designed to have a significant impact on increasing long-term sustainable travel behaviour.

The socio-economic characteristics of the Tyne and Wear region, based on the 2001 census are presented in Table 3.9. It can be seen that the residents of the two major cities in Tyne and Wear: Newcastle upon Tyne and Sunderland have a similar socio-

economic structure. However, as Table 3.9 shows, there are more students (approx. 13% vs. 7%) and better-qualified people in Newcastle than in Sunderland (20.9% vs. 12%, respectively). Also, Newcastle commuters tend to use public transport more (25%) and driving to work less (53%) than residents of Sunderland (17% and 63%, respectively). The selection of Tyne and Wear for this study is supported by the way public transport is more heavily used than in the other two regions as well as by socio-economic characteristics of the region.

Census 2001 question	Tyne and Wear characteristics [%]	Newcastle upon Tyne characteristics [%]	Sunderland characteristics [%]
Households with no car/van	42.0	45.2	39.9
Households with 2 or more cars/vans	16.6	15.4	18.2
Economically active males (full-time)	67.0 (47.5)	64.2 (42.8)	66.8 (48.0)
Economically active females (full-time)	54.9 (27.6)	52.9 (26.8)	54.7 (27.2)
Travel to work by car	59.0	53.0	63.1
Travel to work by public transport	21.0	25.3	17.5
Travel to work on foot	9.6	11.1	9.8
One person household	32.6	35.1	29.3
Couple with no children household	15.6	14.4	15.8
Housing tenure: owner occupied	58.7	53.3	60.2
Housing tenure: private rented	6.4	10.7	4.7
Highest qualification attained level 4/5	15.1	20.9	12.0
No qualifications	35.2	32.6	36.9
Full time students (males/females)	7.8/7.8	13.3/13.6	7.1/6.8
Occupations: managerial	11.0	11.3	10.3
Occupations: professional, technical	22.3	27.9	18.7
Occupations: admin and secretarial	13.9	13.2	13.2
Total population [count]	1,075,938	259,536	280,807

Table 3.9 Selected socio-economic characteristics of Tyne and Wear. Source: Tyne and Wear Research and Information (2004) based on England and Wales 2001 census.

3.5.2 Public transport in Tyne and Wear

There are two main organisations shaping transport policy in Tyne and Wear: the Integrated Transport Authority and Passenger Transport Executive. Most regions (metropolitan and other authorities) in the UK have an Integrated Transport Authority (ITA) and its role is to promote and develop public transport locally. Tyne and Wear ITA (TWITA) has sixteen representatives covering all five district councils in the county and to fulfill the aim of the TWITA, which is:

> *"To ensure that Tyne and Wear has a fully integrated multi-modal transport system that meets the general needs of people who live and work in and travel through the area and which underpins the social and economic fabric of the conurbation."*
>
> *Tyne and Wear Integrated Transport Authority (2011)*

In March 2011 TWITA introduced the third five-year Local Transport Plan (LTP) and Bus Strategy. The plan focuses on a vision of a "fully integrated and sustainable transport network" (Tyne and Wear Integrated Transport Authority, 2011, p. 56). TWITA states that demand for travel can be shaped by providing a variety of travel choices, up-to-date information about travel options, and also by promoting sustainable modes of travel and their benefits. One of the ways of achieving the vision is by encouraging more people to cycle, to walk and to use public transport. This plan will be implemented in Tyne and Wear over the next ten years by promoting the Smarter Choices programmes (see www.gosmarter.co.uk), travel plans and car clubs (see www.co-wheels.org.uk).

Nexus (www.nexus.org.uk) is the Tyne and Wear Passenger Transport Executive (PTE) responsible for the co-ordination of the public transport network, which includes bus links, ferry, rail and metro. The PTE in Tyne and Wear, plans public transport and administers funds for subsidy on behalf of the Passenger Transport Authority (PTA).

Tyne and Wear Metro (Figure 3.2) is a light rail system with 60 stations linking the five main regions in the metropolitan county. The first section of the metro system was opened in 1980 and the most recent station in 2008. Bus links are provided by three main bus operators (Stagecoach, Go North East and Arriva) and a number of smaller bus and taxi companies. Ferry crossings across the River Tyne link North Shields with South Shields. All these transport modes build a good public transport system for Tyne and Wear.

It is likely that the well developed transport infrastructure for the size of the conurbation and the level of car ownership in Tyne and Wear explains the relatively higher mode share for public transport, as compared to Greater Manchester and West Midlands. This well-developed public transport network supports the use of Tyne and Wear as a study area, especially in relation to the identification and exploration of excess commuters using public transport (high use of public transport for commuting was identified as one of the reasons for selecting the UK for the case study, see Section 2.6.1).

Figure 3.2 Tyne and Wear's bus and metro stations map. Source: www.newcastlegateshead.com

3.5.3 Identification of the study's sample

To address the hypotheses of this research, a sample of commuters with alternative public transport travel options for their commute is required. Two alternative methodologies are investigated to identify such a sample: the use of GIS to identify geographical 'hotspots' containing worker's origin locations characterised by a high proportion of public transport travel to work and a destination based sample of an employer employing a diverse socio-economic mix of workers. Selection by origin has the disadvantage of potential respondents commuting to outside the Tyne and Wear study area and conversely, the disadvantage of selection by an employer's destination within Tyne and Wear is that the respondents' home or origin could be outside the study area. The testing of the methodology in a pilot survey (see details in Appendix M) included an assessment of which sampling approach identified the better sample from which to identify and analyse excess commuting.

3.5.3.1 GIS as a tool for selection of 'hotspots' by origin of commute

GIS techniques were used in this research to select sample locations for data collection via the survey questionnaire. GIS data and analysis was employed to choose areas for sampling that were similar to each other within the Tyne and Wear region in terms of geographical features (e.g. type of urban area, proximity of the households to public transport links etc.) and also attributes of these areas (characteristics of the commuting population using census data to obtain details on travel to work by car and public transport modes, and socio-economic characteristics such as employment rate or number of cars in the household). The selection process and details of the characteristics required for the final sample are outlined in the following subsections.

Digital Map Data

The England and Wales Census uses different geographies to present the Census statistics results, including Output Areas (OAs), Super Output Areas and Lower Super Output Areas (LSOAs). Characteristics of the above areas are briefly described in Appendix N. This study uses LSOAs with average populations of 1,500 people and approximately 600 households. Although sample selection at the postcode level was considered for this study, it was rejected for two reasons. Firstly, postcodes classification gives small areas lacking socio-economic diversity and it is not easy to relate census properties of OAs to postcode data. Secondly, LSOAs used a suitable compromise between disaggregated characterisation of population but allows variability to be sampled with selected zones. Moreover, assuming an approximate response rate of 20% from the questionnaires, LSOA is the most suitable zonal unit for achieving the required sample size of 300+ responses, when three or more LSOAs are sampled (600 households x 20% x 3 LSOAs = 360 responses).

England and Wales 2001 census data

Data for each LSOAs had to be joined so that the census variables of each LSOAs were available. The CasWeb service was used to extract information about Tyne and Wear residents (information taken from the England and Wales 2001 census). Aggregate statistic datasets for LSOAs geography were downloaded in CSV format from http://casweb.mimas.ac.uk. Attributes of zone itself (name, size, location) and attributes of population included in the zone (gender, marital status, ethnicity, car ownership, employment, journey to work mode) were selected for the study (Appendix L). The 2001 census data were combined in ArcMap by using a join employing common zone-

codes (e.g. E01008226). The 2001 attributes and their values created a base for future sample selection.

Sampling by origin

Census data was used together with GIS analysis to identify LSOA 'hotspots' in terms of certain characteristics (see below) identified with regards to a number of census and public transport infrastructure criteria. The criteria considered to identify 'hotspots' were that a LSOA should contain a high proportion (over 70%) of people travelling to work (and by implication a low proportion of retired people and people working from home (25% and 10% respectively)). The LSOA should also contain good access to public transport quantified by a close location to metro stations and/or bus stops (e.g. walking distance of 30-40 minutes), with at least average, for Tyne and Wear region, access to a car (according to census 2001 58% of Tyne and Wear households had access to at least one car (TWRI, 2004)). These criteria were designed to maximise the number of people likely to travel for commuting within the sample and to maximise the number of transport mode options available in the sampling area. A number of GIS queries, with high and low values of census attributes, were tested with the purpose of identifying LSOAs most suitable for the excess commuting research. Figure 3.3 presents results of two different scenarios, where a combination of various census data (details listed on the figure below maps) was employed. The first scenario (GISQ1), with results presented in Figure 3.3a, was that:

- 50% or less of households had no car,
- 10% or more of people commuted by bus,
- 50% or more of people commuted by car,
- 10% or more of people commuted as passengers in a car.

Two additional criteria regarding employment were added to the next scenario (GISQ2), which was:

- 50% or less of households had no car,
- 10% or more of people commuted by bus,
- 50% or more of people commuted by car,
- 10% or more of people commuted as passengers in a car,
- 10% or less of people were working from home,
- 40% or more of people worked full-time.

GISQ2 results are presented in Figure 3.3b. As Figure 3.3 shows, when more constraints are put, as in GISQ2 in comparison to GISQ1, less LSOAs meet the criteria (compare highlighted LSOAs on Figure 3.3a and b).

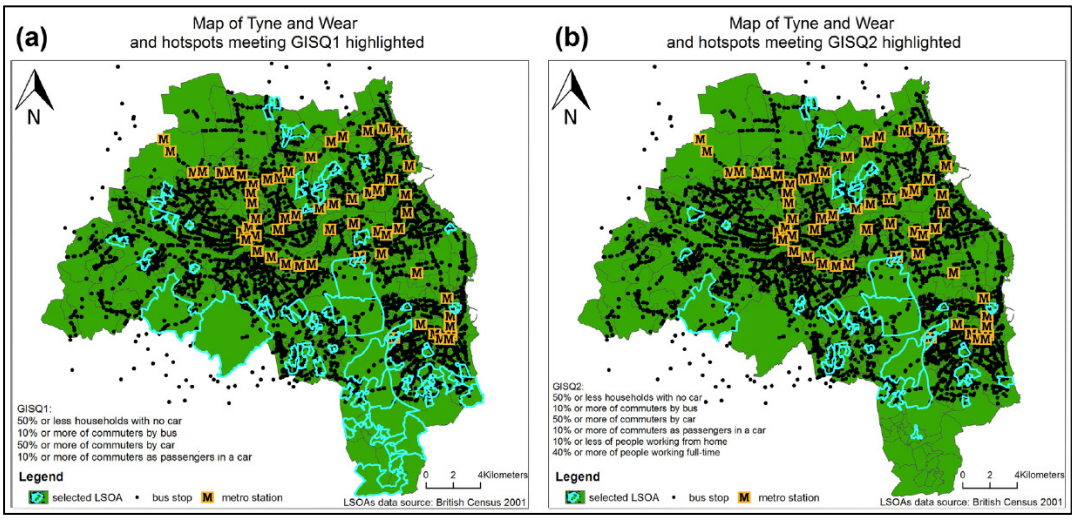


Figure 3.3 Map of Tyne and Wear with highlighted hotspots meeting: a) GIS query 1; b) GIS query 2. Source: Fraszczyk and Mulley (2014)

After testing a number of scenarios the final GIS query was formed. The query specified nine different attributes and their values. The LOAS of final interest were described as areas where:

- 50% or less of households had no car,
- 16% or more of people commuted by bus,
- 50% or more of people commuted by car,
- 10% or more of people commuted as passengers in a car,
- 25% or less of people were retired,
- 10% or less of people were unemployed,
- 10% or less of people were working from home,
- 40% or more of people worked full-time,
- 10% or more of people worked part-time.

As shown on Figure 3.4 the highlighted 17 LSOAs met the requirements of the GISQ3 query. Next, a visual assessment of public transport services (e.g. bus stops, metro stations) in the selected LSOAs was employed to further filter the areas. Five areas in North Tyneside and one in Sunderland, out of the 17 pre-selected, were found to be located close to the existing metro stations (maximum walking time was 40 minutes). In addition, the six LSOAs had a minimum of two bus services covering each of the areas (see Appendix N for detailed maps of the six LSOAs with bus stops and metro stations marked). The good public transport links are due to the fact that the North Tyneside's LSOAs are located along a main transport corridor between Newcastle and the coast,

and the sixth LSOA is located in the suburbs of Sunderland. As described in more detail in Fraszczyk and Mulley (2014), this selection process could have been more sophisticated if geographical information (e.g. distance to metro stops) was used in the GIS query. However, in this case the cost of geocoding the data in terms of time would have far exceeded the benefits of adding the geographical information to the query. Therefore based on the GISQ3 results and the visual assessment of public transport services the six LSOAs, highlighted in red on Figure 3.6, were selected for the research.

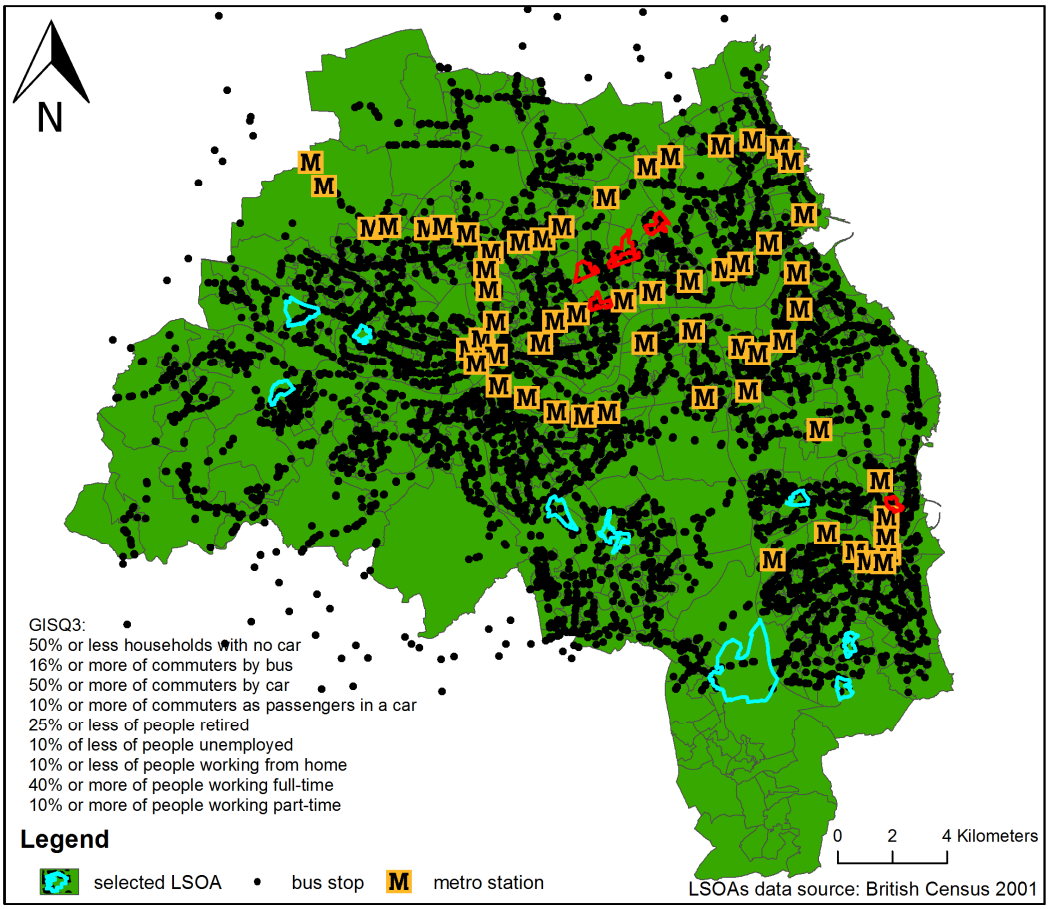


Figure 3.4 Map of Tyne and Wear with highlighted (blue) hotspots meeting GISQ3 query and the final six LSOAs selected (highlighted in red). Source: based on Fraszczyk and Mulley (2014)

Table 3.10 presents the final six LSOAs in the context of the nine final criteria. In each of the six areas over 60% of residents were working (at home, full time or part time) and approximately 25% of residents were out of job (retired, unemployed or sick/disabled). All areas are identified as suitable LSOAs for sampling although Area F (Seaburn in Sunderland), identified as meeting the requirements, only received metro access after the census data was collected in 2001. This means the travel-to-work data collected in the survey would certainly be different from that identified by the 2001

census, thus making establishment of representativeness to the population difficult. Seaburn, however, has a distinctive land use pattern in comparison with the North Tyneside's five LSOAs (terraced houses versus semi-detached and detached houses) and offers the opportunity to examine if the number and characteristics of excess commuters are distinctly different from other areas.

Attribute	Min value [%]	Max value [%]	Lower Super Output Areas					
			Walker-ville (A)	Hyde Park (B)	Battle Hill Drive (C)	Wark-worth Ave (D)	Hadrian Park (E)	Sea-burn (F)
Retired	2.0	36.2	17.1	12.1	15.2	9.1	15.6	15.8
Unemployed	0.7	15.7	2.8	4	3.3	3.2	2.4	3.4
Sick/disabled	1.3	23.6	5.8	5.9	7.0	5.6	6.0	8.9
Working at home	3.0	15	8.0	8.0	7.0	5.0	6.0	6.0
Working part-time	1.8	16.9	14.2	12.8	13.5	13.2	15	11.5
Working full-time	7.8	62	40.5	47.9	43.9	51.7	42.3	45.5
Student	1.0	62.8	3.8	2.7	3.0	3.4	4.3	2.9
0 car in HH	4.0	84.0	29.0	28.0	34.0	28.0	31.0	34.0
Travel to work – metro	0.0	25.0	5.0	3.0	2.0	3.0	1.0	0.0
Travel to work – bus	1.0	38.0	17.0	17.0	18.0	16.0	19.0	16.0
Travel to work – driving	21.0	74.0	52.0	52.0	51.0	54.0	52.0	52.0
Travel to work – passenger in a car	2.0	16.0	10.0	10.0	11.0	11.0	10.0	10.0

Table 3.10 Values of attributes for six selected Lower Super Output Areas. Source: England and Wales Census 2001

3.5.4 Sampling at the destination of commute

The second sampling strategy employed was to recognise individuals at their workplace destination. Here, the needs of the research required the workplace to be located in a city centre to secure good public transport links with an employer large enough to secure a significant number of employees (respondents) with a range of socio-economic characteristics. Sampling such a workplace should capture and compare a wide spectrum of travel behaviour and travel choice between different socio-economic groups and demographic profiles e.g. age, employment sector, residence location.

After comparing the main employers located in the city centres of Newcastle and Sunderland (the two large cities in the Tyne and Wear conurbation, each with a population of over 260,000) two main employers based in the centre of Newcastle were selected: Newcastle City Council (NCC) and Newcastle University (NU). None of the large employers based in Sunderland (e.g. Gentoo, Sunderland City Library) were selected because the estimated population of employees did not meet the minimum

sample size requirements (n≥300 respondents). It must be noted that both NCC and NU are public organisations and this fact may influence the ability to generalise the sample, as the majority of their employees will occupy administration or higher education sector positions (e.g. no retail or commercial organisations considered). This is not a requirement for meeting the needs of research but an outcome determined by the requirements of size and employee diversification. Therefore it must be admitted that the results of the destination survey are likely to be only relevant to a particular socio-economic group, namely public sector employees.

NCC employs approximately 15,000 people (Department for Business, Enterprise and Regulatory Reform, 2008) and its largest building (the Civic Centre) is located in the city centre. The building is surrounded by excellent public transport infrastructure with Haymarket Metro Station, Haymarket Bus Station and a number of single bus stops close to the building. In 2006 the council opened its Corporate Travel Office with the purpose to support "cost effective and energy efficient journeys and discourage travel by car" (Directorate-General for Energy and Transport, 2010).

NU is a large employer with approximately 5,000 staff (www.newcastle.ac.uk). It is situated in Newcastle City Centre, with the main campus opposite the Civic Centre. Public transport links are very good with access to Haymarket Metro Station and Haymarket Bus Station and a variety of bus stops close to the campus. The University developed a Travel Plan with "measures aimed at promoting sustainable travel, with an emphasis on the reduction of reliance on single occupancy car travel" (Newcastle University, 2009).

It is recognised that given the close proximity of the two employers and a strong public transport infrastructure in the centre of Newcastle, it is likely that results might be geographically biased. However, the aim of the study is to test excess commuting where commuters have various transport alternatives available and from this perspective the choice of the two employers is justified.

3.6 Testing the questionnaire and sampling methodology in a pilot study

A pilot study was undertaken to test the questionnaire methodology, in terms of its questions and delivery. The pilot study undertook origin sampling for one of the

identified LSOAs (Walkerville, Area A in Table 3.10) and for one of the destinations, Newcastle University.

The pilot process involved the delivery of the questionnaires, according to whether it is an origin or destination sample as described above. The returned questionnaires were fully analysed to ensure the methodology enabled suitable data to be identified for analysis and whether an origin or destination based sample was superior in this respect. The analysis of the pilot data was not anticipated to produce statistically significant results but was undertaken to ensure that the data was suitable. The analysis of the pilot data is presented in Appendix M. This section focuses on lessons learnt from the pilot study in terms of the questionnaire and delivery methodologies to inform and shape the final questionnaire and choice of delivery method. The main issues for suggested improvements are discussed below.

3.6.1 Delivery methodology

Both origin and destination methods were used in 2008 in the pilot study. The first sub-sample targeted 280 questionnaires delivered to 46% of households in area A: Walkerville (see area A in Table 3.10) as an origin based sample. Overall, 63 questionnaires were returned giving an overall response rate of 22.5%. Of these 45 were fully completed questionnaires, where respondents reported postcodes of origin and destination and answered all (or most of) the questions with useable data.

The second sub-sample was destination based and targeted employees from the School of Geography, Politics and Sociology (the GPS) at Newcastle University. The Head of School was approached to support the distribution of the questionnaires via the online version as well as hard copies to approximately 100 employees in the School. In total there were 35 online and 7 hard copy responses to the questionnaire, with 40 suitable for further analysis. The online approach, with 40 useable pilot questionnaires collected, proved to be a good data collection alternative for the origin-based survey, but did not allow socio-economic characteristics of the sample to be compared against the employees' population within the GPS School as no employees data was available. The data collected via the online method was combined with the data from paper-based questionnaires and no discrepancies in terms of response quality were found.

After analysis, the GIS-based sample selection method appears better for three main reasons. The first is that the 'hotspot' generation methodology gives good background information regarding the general socio-economic characteristics of the targeted population (see Table 3.10 in Chapter 3), which then allows a comparison of these characteristics with collected results from the sample. The second is that GIS allows the specification of the geographical location of the sample, which helps to identify transport alternative options between selected origins and reported destinations. Moreover, if self-reported data regarding the origin is missing it is still possible to identify the location (i.e., the area where paper-based questionnaires were delivered). The third reason is that a good response rate of over 20% was achieved in the pilot study reducing the worry that the main survey would not give rise to sufficient respondents. Assuming that 50% of households in the five remaining LSOAs (there are approx. 600 households in each LSOA) will be targeted in the main study, the expected number of returned questionnaires would be approximately 300. A sample size of 300 respondents or above would be satisfactory for the statistical analysis planned in the main study (e.g. factor analysis; Field (2009)).

3.6.2 Gender bias

As with Mokhtarian *et al.* (2001) and other transport surveys, there were many more female respondents than males in the pilot survey (64% for the Walkerville and 70% for the GPS sub-samples). Gender bias is difficult to deal with and a more balanced sample in terms of age, sex, gender etc. would provide a better starting point for excess commuting analysis. This outcome suggested the revised questionnaire should be more encouraging of male respondents by improving the instructions in each questionnaire to highlight that males as well as females are encouraged to complete the survey and that this is important for the study to have a representative sample in terms of age, gender and occupation. Moreover, in the case of paper questionnaires delivered door-to-door, engagement where possible in one-to-one chats about the study with residents of the all selected LSOAs offered another opportunity to increase the engagement of male respondents, although questionnaire distribution took place in working hours between 9am and 7pm).

3.6.3 Effort

Although the literature review presented in Chapter 2 Section 2.4.1 identified effort as one of the parameters of excess commuting (other parameters considered are time,

distance and cost), the pilot questionnaire failed to gather meaningful information on effort related to travel to work, which could be effectively used in subsequent analysis. Effort is difficult to measure objectively as it is an individual perception of how hard an activity is. For example, a fit person may jog to work with little effort but the same journey would be considerable effort for someone who is unfit.

In revising the questionnaire, a number of new questions were included to better measure the subjective effort in travelling. These are based on Stradling's (2002, 2006, 2011) work on the psychology of travel choice and the different types of effort involved when travelling. The new questions are related to three types of effort: physical, cognitive and affective. Physical effort relates to the different types of effort involved in walking, waiting and carrying and the overall effort in commuting sub-divided. Cognitive effort is related to the mental effort involved in travelling and requires questions about route and transport mode, advance planning of the journey and progress checks. Affective effort relates to the emotional effort and is addressed by asking questions as to why commuting might be stressful. The new questions with answer options are presented below in Table 3.11.

Type of effort	Question	Available answers
Physical	How much effort do you spend: - Walking - Waiting - Carrying goods	Far too much/Too much/About right/Too little/Far too little
	How much overall effort does your journey to work involve?	Far too much/Too much/About right/Too little/Far too little
Cognitive (mental)	When you travel to work, do you always take the same: - Route - Transport mode	Yes/No
	Do you plan your journey to work in advance?	Yes/No
	If you plan your journey to work in advance, what do you plan?	Open question
	During your commute do you keep watching to check your progress?	Yes/No
Affective (emotional)	Is your travel to work stressful?	Yes/No
	If your travel to work is stressful, is it because you worry about: - being late for work - your personal safety - other, please specify	Yes/No

Table 3.11 Questions in the main questionnaire related to effort.

As Table 3.11 shows, eight additional questions are included in the revised questionnaire: two questions about physical effort, four questions about cognitive effort

and two questions about affective effort. Each question apart from one has a clear answer option (Yes/No or 5-point attitudinal Likert-scale) to make it easy for a respondent to reply. One question about planning a journey to work in advance gives space for an open answer. All these effort questions are related to H3 of this study, which explores dependent and independent factors influencing travel choices.

3.6.4 Car availability

Detailed questions about a car ownership and use were not originally included and, as a result it was not possible to identify respondents who had access to a car and those who did not. This was addressed by asking a direct question as to whether the respondent has access to a car as an alternative mode. Moreover, one new question related to car accessibility was added to the main questionnaire with the purpose of specifying if a respondent has a *real* access to a car (as potential travel-to-work mode) or not. This question is linked to H2, which examines socio-economics, lifestyles and attitudes of respondents and their links with peoples travel behaviour.

3.6.5 Focus on travel to work

The pilot questionnaire asked questions related to work as well as non-work travel. After consultations with experts in transport and travel behaviour from the Transport Operations Research Group at Newcastle University, and after analysing the pilot study results, the purpose of including non-work related statements was questioned in this study as the main focus of the research is commuting. All non-commuting questions have been removed in the revised questionnaire so that part one and part two of the main questionnaire included questions related to travel-to-work behaviour only.

3.6.6 Delivery Process

The pilot questionnaire delivered to origin based respondents used a reminder card, which contained information about the survey only and did not appear to have a demonstrable effect on the number of returned questionnaires. This is most likely because those households who had not replied may no longer have the questionnaire (lost or thrown away). A revised procedure needed to include an additional copy of the questionnaire which was delivered with the reminder letter.

In addition, the pilot questionnaire did not use any tracking system (although all targeted households were recorded) and so it was not possible to identify which

households responded to the first questionnaire and which should be targeted with the reminder card. The revised delivery method included a unique number on each envelope with the questionnaire and the covering letter as well as on each pre-paid envelope to allow the identification of a replying household so that non-responding households could be targeted with a reminder letter and additional copies of the questionnaire.

3.6.7 Questionnaire re-design

The pilot questionnaire used a number of open-ended questions. After analysing the responses received a number of categories emerged which allowed specific answers to be provided for some questions. Using set answers instead of open-ended questions facilitates completion for respondents as well as making coding of the data easier for the researcher. Three examples of open-ended questions from the pilot survey and their new versions for the main questionnaire are presented in Table 3.12.

Pilot questionnaire	Main questionnaire
Please describe alternative transport modes or options of travel to work you have and the reasons why you are not using them (e.g. I can take a bus, but the bus stop is too far) [open question]	**Please describe any transport alternatives for your travel to work:** - Underground, metro, light rail - Train - Bus, minibus or coach - Motorcycle, scooter or moped - Driving a car or van - Passenger in a car or van - Taxi or minicab - Bicycle - On foot - Work mainly at or from home - Other - No alternatives
	If you do have transport alternatives what is the reason why you are not using them? Tick the 3 most important reasons. - More expensive - More time consuming - Require more effort - Less comfort - Parking problems - Dislike public transport - Bad for environment - Need of flexibility - Current option safer - Other
What kind of activities would you like to do during your commuting time, but you can't right now? [open question]	**Which activities would you like to do during your travel time, but you can't right now?** Tick the 3 most important activities. - Do useful work - Use laptop - Use Internet - Read a newspaper - Listen to the news - Listen to music/radio - Watch TV - Read a book - Have a quiet space - Sleep - Other, please specify

What could public transport operators do to encourage you to use local services more often instead of private transport? Please name activities or services which would convince you to use public transport more often. If you have any new ideas, never stated before, please feel free to write them below.	**What could encourage you to use public transport services more often instead of private transport?** Tick the 3 most important reasons. - More direct routes - Safe bus stops - Up-to-date timetables - Electronic fare payments (like Oyster in London) - Upgraded vehicles - Regular & reliable service - Friendly staff - Cheaper fares - Other, please specify

Table 3.12 Questions used in the pilot questionnaire and their new versions from the main questionnaire.

The other important improvement to the main questionnaire related to the question on modal switch. The pilot version of this question used a table, which many respondents ignored or only partially completed, which led to little useable data being produced. The pilot version was:

Will any of the following encourage you to switch your transport mode to work (again)? *Please specify your answer. Tick appropriate boxes.*

	No	*Yes*	*Please specify*	*Value*
Cheaper price			*If Yes, how much cheaper?*	*£*
Quicker time			*If Yes, how much quicker?*	*MINS*
Shorter distance			*If Yes, how much shorter?*	*KM*
Combination of other factors			*What other factors? Please specify below.*	
				PLEASE USE CAPITAL LETTERS

This was replaced by a question relating to the price and time variables only and was expressed in four questions, which gave respondents a number of answer options as shown below in Table 3.13.

1. ***How much <u>less expensive</u> per trip would an alternative journey need to be to make you seriously consider switching your commute to this alternative?***
   Please tick one the most appropriate box.

50p	*£1.00*	*£1.50*	*£2.00*	*£2.50*	*£3.00*	*Other*

   If OTHER, please specify:.....

2. ***If your trip was <u>less expensive</u> each time by the amount you identified above, would you switch?***

   Yes ☐ ***No*** ☐

3. ***How much <u>quicker</u> per trip would an alternative journey need to be to make you seriously consider switching your commute to this alternative?***
   Please tick one the most appropriate box.

5mins	*10mins*	*15mins*	*20mins*	*30mins*	*Other*

   If OTHER, please specify:.....

4. ***If your trip was <u>quicker</u> each time by the amount you identified above, would you switch?***

   Yes ☐ ***No*** ☐

Table 3.13 Questions related to modal switch used in the study.

One question about the type of area a respondent lived in with two answer options – rural or urban – was removed as this could be identified via analysis of postcodes. The final questionnaire, incorporating these lessons learnt is available in Appendix F.

3.7 The main survey

The objective of the sampling for the main survey was to collect 300 or more responses. A first sample was achieved by the delivery of questionnaires to five of the six LSOAs shortlisted prior to the pilot study. Unfortunately, for the reasons beyond the control of this research (which are explained below in Section 3.7.1), the number of paper responses received was very low and it was necessary to use a second approach. The second sample was achieved through an online questionnaire targeted at a destination-based sub-sample. As a consequence of using two different approaches the main survey sample consists of two sub-samples and these are described in the next two sections.

3.7.1 Main sample – paper questionnaires

In early July 2010, 1,640 paper questionnaires with covering letters, pre-paid envelopes and free gift of a pen) were delivered to 50% of the households in the five areas of Tyne and Wear recognised in Section 3.5.3.1. In order to aid the subsequent analysis of retuned questionnaires residents in different areas received questionnaires in a different colour. In order to recognize individual respondents each pre-paid envelope was marked with a unique number and recorded in order to target reminder letters.

By the end of July 2010 1,640 households had received the questionnaire. However by the initial 'closing' date of the survey at the beginning of August 2010 only 15 responses had been returned to the School of Civil Engineering and Geosciences, 1% of the total number of questionnaires distributed. The 1% response rate, compared to the pilot response rate of 22.5%, suggested that there had been a problem with the return of responses. Initial investigation concentrated on mail delivery within the University but this did not identify any missing returns. Consequently, the Post Office was contacted which revealed that the license used on the pre-paid return envelopes was suspended by the Royal Mail without notifying the Civil Engineering and Geosciences School office as the license holder. Cancellation of the license brought into play a number of further actions by the Post Office who were following their standard procedures. The critical aspect of the procedures is that Post Office require undelivered items to be returned to sender after 21 days. As the survey was anonymous they could not be sent back to the senders and the second part of the Post Office procedure is implemented which was to destroy the undelivered items. This was despite the fact that each envelope showed the Civil Engineering and Geosciences School office address; the Post Office chose not to contact the School office.

When this came to light, urgent action was taken to retrieve the responses, which had not been destroyed. In all, by mid-August 151 responses had been saved from destruction (Table 3.14) following the payment of £227.68 (including a handling fee) being paid to the Post Office. Post Office employees commented that hundreds of letters had been received and the number destroyed was well over 600. A careful analysis of the retrieved questionnaires identified the number of replies useful for analysis was below 100 (Table 3.14) and that such a small sample size was not appropriate for the main analysis of the study.

Variable		Hyde Park	Battle Hill Drive	Warkworth Avenue	Hadrian Park	Seaburn
Number of:	People in LSOA	1423	1495	1477	1495	1554
	Commuters	759	720	707	820	754
	Households	609	648	655	617	748
	Households targeted by the questionnaire in July 2010	305	324	328	309	374
Final number of returns		26	11	15	16	13
Final response rate [%]		8.5	3.4	4.6	5.2	3.5

Table 3.14 Characteristics of five LSOAs and number of questionnaires distributed. Source: England and Wales 2001 census.

3.7.2 Main sample – online questionnaire

In order to try and obtain a larger number of respondents that would allow statistical analysis a second main survey distribution of the questionnaire was undertaken. Due to lack of resources, limited research budget and the time critical nature of obtaining a large enough set of respondents for the main survey, a second online survey was conducted. Although the pilot study suggested that this was a less successful method than the GIS approach it was considered appropriate given the circumstances above, and the resourcing and timing issues outlined.

In September 2010, the Tyne and Wear Local Transport Plan Core Team (LTP) was approached to support the online survey. The LTP is a five-year statutory document prepared in Tyne and Wear jointly by the five local authorities: Newcastle, Gateshead, North Tyneside, South Tyneside, Sunderland and the Passenger Transport Executive; Nexus (www.tyneandwearltp.co.uk). The LTP team was keen to promote the survey across the five local authorities and following discussions with LAs representatives on 15th September 2010 it was agreed that they would actively promote the on-line survey. However, Sunderland City Council declined to circulate the survey on several grounds; the fact that the online survey used Smart-Survey as a survey tool which conflicted with their ITrace survey tool, secondly a fear of 'over surveying' employees and finally the promotion of this survey would clash with the Council plans to engage with a cycling survey run by the Health Sector. North Tyneside Council also declined to circulate the survey, on the grounds that travel to work was a sensitive issue as at the time of survey it formed part of a wider debate over staff terms and conditions. Gateshead and South Tyneside did not respond to the LTP's call to promote the survey and it was thus assumed that they were not interested in taking part in the survey.

In addition to promotion of the survey via the LTP, the survey was also promoted in "News in brief", an e-newsletter published by Newcastle City Council (NCC) for their employees. In both cases the promotion of the on-line survey included a brief description of the purposes of the survey and mentioned a £25 shopping voucher prize draw that all respondents would be entered into. A copy of the newsletter can be seen in Appendix G. The online survey was closed for respondents on 13th October 2010 with total number of 157 online questionnaires completed by NCC employees.

3.7.3 Final sample size

The total number of questionnaires returned by respondents from the two sub-samples totalled 308. However, after data cleaning 223 questionnaires were assessed as being usable for the further analysis. The questionnaires rejected from the final sample included examples where some responses omitted postcodes for origin and/or destination (therefore, it was not possible to identify locations of home and/or work and as a consequence difficult to suggest alternative transport options), or some respondents worked from home (no physical travel was undertaken therefore no excess commuting could occur). Table 3.15 shows the final composition of the sample, where 81 residents are from the five LSOAs (32 colour questionnaires from the 1st delivery and 49 white questionnaires from the 2nd delivery) and 142 employees from NCC.

Delivery	LSOA					Total
	Hyde Park	Battle Hill Drive	Warkworth Avenue	Hadrian Park	Seaburn	
1st paper	15	2	3	5	7	32
2nd paper	11	9	12	11	6	49
Total returns	26	11	15	16	13	81
Online	-	-	-	-	-	142
Total number of questionnaires used in the main study analysis						223

Table 3.15 Total number of returned questionnaires useful for further analysis [count].

3.8 Summary

This chapter has presented the methodology developed for the pilot study and based on the lessons learnt from this pilot further refined the questionnaire design and delivery for the main study.

The previous chapter identified four research gaps for the study and the aim of the methodology described in this chapter is to provide a framework to provide answers to these gaps. The first gap was to focus on a new UK-based case study and Tyne and

Wear was suggested as a good region for undertaking new research on excess commuting. Socio-economic characteristics of Tyne and Wear as well as public transport network were described in more detail in order to show that this medium sized regional area is suitable for undertaking travel behaviour study.

The second gap placed the emphasis on collecting information about travel behaviour of individuals. Therefore a questionnaire methodology has been developed, where a number of questions tested in a pilot study asked respondents about their last journey to work, as well as their attitudes and preferences relating to travel. Based on the pilot analysis a number of recommendations related to the questionnaire re-design and delivery strategies were drawn for the main survey.

The third gap was to focus on the different transport modes available for travel to work when researching excess commuting. The pilot questionnaire included a number of questions related to private (car) as well as public (bus or metro) transport options available in the study area. Moreover, the questionnaire tested respondents' knowledge about alternative transport options for their travel to work, which could be easily verified by researcher by studying public transport services in the six selected areas.
The final research gap highlighted a need for a clear methodology for identifying excess commuting behaviour. Two methods were suggested for testing the phenomenon: firstly – 'pure' values and secondly – 'generalised cost' formula. The two methods were not tested in the pilot study, as not enough responses (n=65) were collected to run statistically significant analysis of the sample. Instead the two methods were rigorously implemented in the main study and results of their analysis are presented in the next chapter.

Chapter 4. Analysis of Results

4.1 Introduction

The aim of this chapter is to present the results of this study's main survey in the context of the three hypotheses presented in Chapter 3. Section 4.2 focuses on the first hypothesis (H1) which tests whether excess commuters can be identified. The section analyses 'pure' time, 'pure' cost and 'pure' effort results for excess commuters (EC) and non excess commuters (NEC) selection which are compared with generalised cost results (see Chapter 3 Section 3.4 for details of the four methods used). Section 4.3 considers the second hypothesis (H2), which is to test whether travellers exhibiting excess commuting can be identified by their socio-economic characteristics, lifestyle or attitudes to travel. Section 4.4 investigates the third hypothesis (H3) of this study, which is to test the relationship between different factors influencing travel choices and the propensity for excess commuting. This section compares transport alternatives for travel to work journeys, analyses time and cost savings and perception of effort spent on commuting. Section 4.5 analyses respondents opinions about public transport services and identifies factors, which could help to increase public transport usage for commuting. The final section, 4.6, presents the main conclusions from the analyses and assesses the degree to which the analyses presented in this Chapter have contributed to confirming or rejecting the three hypotheses of this study.

4.2 Analysis of Hypothesis One

The first hypothesis (H1) of this study states that "Excess commuters can be identified in their commuting behaviour", where the null hypothesis is that they cannot be identified in their commuting behaviour (see Chapter 3, Section 3.2). There are different approaches possible for identifying excess commuting (see Chapter 2 for examples) and this study uses two contrasting methods to identify EC: 'pure' results and generalised cost calculations. In both methods self-reported results from the respondents are compared with four transport mode alternatives, using the same origin and destination points. Seven saving options in relation to self-reported options are considered for time and cost parameters with the minimum saving of 5% and the maximum of 50% or more. The four alternatives are: car (OPT1), public transport (OPT2 and OPT3) and walking (OPT4).

4.2.1 Time excess commuters

The questionnaire asked respondents to describe their most recent journey from home to work step by step (see part 1 question 4 in Appendix F). 101 out of 110 respondents using private transport modes ignored walking times to and from the vehicle and stated only the time spent on a particular vehicle (car, scooter, car & bike) as their total travel time. Fortunately in a different question (see part 1 question 8 in Appendix F), the questionnaire asked respondents for total travel time and monetary cost of their one-way commute. The results from both questions were then compared and when perceived walking, waiting and in-mode times were self-reported in detail then all times were added together to record total one-way travel to work time for each respondent.

The results of the Kolmogorov-Smirnov (K-S) test, presented in Table 4.1, show that the distribution of travel time scores for the total sample of 223 respondents is statistically significant non-normal ($D(223) = 0.12$, $p<0.01$), suggesting the median is a better measure of central tendency.

Kolmogorov-Smirnov			Mean	Standard deviation	Median	Minimum value	Maximum value	Sample size
Statistic	df	Sig.						
.127	223	.00	28.30	15.46	25.00	3.00	90.00	223

Table 4.1 Results of the test of normality (K-S) for the travel time parameter [mins] and mean values.

The median self-reported travel time for the total sample is 25.00 minutes with a standard deviation of 15.46 where the minimum self-reported travel time is 3.00 minutes and the maximum is 90.00 minutes.

Time savings for the four alternative options in relation to the self-reported option were calculated and results are presented in Table 4.2. The results show that 139 respondents (62%) had equivalent car journeys that were quicker (although they might not be willing/able to use the car) and 46 (21% of the sample) could use public transport (OPT2 or OPT3) as quicker alternatives. The walking option (OPT4) is more attractive, in terms of travel time savings, than the current journeys for the maximum of three respondents (1%) only.

Alternative option		Travel time savings in relation to self-reported time						
		≥5%	≥10%	≥15%	≥20%	≥30%	≥40%	≥50%
Car (OPT1)		139	130	118	116	98	79	49
Public transport		46	38	33	27	12	6	1
Walking (OPT4)		3	2	2	1	0	0	0
Total number of unique respondents saving travel time (all alternative transport options combined)	[count]	160	146	131	124	101	81	49
	[%]	72%	65%	59%	56%	45%	36%	22%

Table 4.2 Number of respondents saving travel time if an alternative option was chosen [count]

There are 163 driver licence holders with access to a car within the sample. The results presented in Table 4.2 show that there is a substantial number of respondents for whom the car alternative (OPT1) offers from 5% to over 50% travel time savings in comparison to the self-reported option. Public transport alternatives also offer time saving options for a sizable part of the sample (maximum 20%), although the total number of respondents who could save travel time using OPT2 or OPT3 is between 46 (for 5% savings) and 1 (for the 50% or more savings) respondents only.

For example, if a minimum of 5% travel time saving is applied, then the number of unique respondents exhibiting excess commuting in terms of travel time in at least one of the four alternatives is 160 (5% rule offers 1.40 minutes savings on average), and in the case of 20% travel time savings (5.30 minutes savings on average) the number of individuals drops to 124. 50% or more travel time savings (14 minutes savings on average) are achievable for one respondent only when considering public transport, while for driving option the result is 49 individuals.

4.2.2 Cost excess commuters

It is well documented that perceived self-reporting of car usage costs are notoriously underestimated. Britton (2011) identifies that some people do not recognise any monetary costs associated with their travel to work by car and simply ignore fuel, parking and other maintenance costs and believe that their trip is monetary free.

The scores of self-reported cost of one-way travel were tested for normality and results presented in Table 4.3 show that distribution of scores is not normal ($D(173) = 0.15$,

p<0.01). The median self-reported travel cost for the sample (173 respondents provided their travel costs) is £1.60.

Kolmogorov-Smirnov			Mean	Standard deviation	Median	Minimum value	Maximum value	Sample size
Statistic	df	Sig.						
.159	173	.00	1.93	1.93	1.60	0.00	10.45	173

Table 4.3 Results of the test of normality (K-S) for the travel cost parameter [£] and mean values.

As in the pure time case, the pure cost was calculated for all 223 respondents, and based on their self-reported costs and the costs for the four alternatives. Results for travel cost savings in relation to self-reported cost are presented in Table 4.4. After calculating monetary costs for all respondents it was found that when the minimum 5% margin was used, a maximum of 13 people (6% of the sample) could save money if an alternative car option was used, and the maximum of 100 respondents (45% of the sample) could benefit from using public transport alternatives.

Alternative option		Travel cost savings in relation to self-reported cost						
		>=5%	>=10%	>=15%	>=20%	>=30%	>=40%	>=50%
Car		13	12	11	10	9	7	5
Public transport		100	86	80	71	58	44	35
Total number of individual respondents for combined alternative transport options	[count]	100	86	80	71	58	44	35
	[%]	45%	39%	36%	32%	26%	20%	16%

Table 4.4 Number of respondents saving travel cost if an alternative option was chosen [count]

However, when 20% margin is applied then the number of individuals exhibiting EC in terms of monetary cost in at least one of the four alternatives is 71. This 20% threshold offers on average saving of £0.38 on a single commute trip (£0.76 per day). In the case of the 50% margin the number of individuals meeting the criteria drops down to 35, meaning that 16% of the sample could save half or more of their one-way commuting cost (£0.96 on average) when using one of the alternatives.

4.2.3 Effort excess commuters

Travel time and monetary cost analyses presented above both used quantitative methods, but a more qualitative approach was employed in the effort analysis as the

effort parameter is more difficult to assess quantitatively due to its psycho-physical nature (see Chapter 3 Section 3.4.1.3).

Following the simple scoring system for identifying effort excess commuters presented in Table 3.6 in Chapter 3 the results for the 223 respondents were calculated. As Table 4.5 shows 38 respondents were classified as effort EC for the car option and 153 as effort EC for public transport options, giving the total of 174 effort EC.

Alternative option	Physical effort	Cognitive effort	Affective effort	Total effort [count]	Total effort [%]
Car (OPT1)	131	160	39	38	17%
Public transport (OPT2)	124	209	0	78	35%
Public transport (OPT3)	169	184	0	132	59%
Public transport (OPT2 + OPT3)	-	-	-	153	69%
Total number of individual respondents for combined alternative transport options	-	-	-	174	78%

Table 4.5 Number of respondents saving effort if an alternative option was chosen [count]

Overall, 174 respondents were classified as effort EC and results for this group are compared against the results within the remaining three groups (time, cost and generalised cost). The group membership is not mutually exclusive meaning that respondents identified as EC within the effort group might also be EC within for example the time group. Table 4.6 below presents the number of individuals classified as EC across selected group combinations for car and public transport options. For example, of the 100 generalised cost EC, 99 were also pure time EC, 35 were also pure cost EC and 92 were effort EC.

Option	Parameter	Time	Cost	Effort	Generalised cost
Car (OPT1)	Time	116	8	38	96
	Cost	-	10	2	8
	Effort	-	-	38	37
	Generalised cost	-	-	-	97
Public transport (OPT2 + OPT3)	Time	27	10	16	3
	Cost	-	71	43	3
	Effort	-	-	153	1
	Generalised cost	-	-	-	3
Car + public transport combined	Time	125	41	112	99
	Cost	-	71	49	35
	Effort	-	-	174	92
	Generalised cost	-	-	-	100
	-	3			-
	-	1			

Table 4.6 Number of excess commuters identified across various groups for the 20% saving option [count]

Table 4.6 reveals that the more parameters that are taken into account in EC identification, the smaller the number of EC. For example only 3 time, cost and effort EC existed. Moreover, when generalised cost results are considered the number of EC meeting the 20% threshold for the three parameters and generalised cost is reduced to 1 respondent only.

4.2.4 Generalised cost excess commuters

Results for each individual were calculated and 13 weight options were taken into account. The results are presented in Table 4.7. Interestingly for all 13 weights options, greater numbers of EC were identified for the car journey alternative than for public transport alternatives. It can be seen that the number of respondents exhibiting EC varies between 125 (for a saving of at least 5%) and 45 (for a saving of at least 50%) for the car alternative (OPT1)(both values for the 1st weights option). However, 40 EC exist who would gain a 5% or more saving for public transport alternatives (in the 1st weights option), a value that falls to only one (in the 2nd weights option) for a saving of 50% or more (combined OPT2 and OPT3). The numbers presented in Table 4.7 show that a considerable number of respondents could be identified as exhibiting EC on the basis of the generalised cost calculations particularly for the car alternative compared to the public transport options.

The group of respondents exhibiting EC identified through the generalised cost formula for all transport alternatives combined (car, public transport and walking) ranges from 117 to 135 individuals for the 10% margin, and 100 to 112 for the 20% savings margin, when compared with self-reported options.

Weights option for alternatives				Generalised cost savings for car alternative (OPT1) in relation to self-reported generalised cost							Generalised cost savings for public transport alternatives (OPT2 + OPT3) in relation to self-reported generalised cost (numbers for combined OPT1+OPT2+OPT3 in brackets)						
No	**V** WALK	**V** WAIT	**I** NTER-CHANGES	**≥5%**	**≥10%**	**≥15%**	**≥20%**	**≥30%**	**≥40%**	**≥50%**	**≥5%**	**≥10%**	**≥15%**	**≥20%**	**≥30%**	**≥40%**	**≥50%**
1	1	1	0	125	114	104	97	73	58	45	40 (148)	35 (135)	29 (121)	23 (112)	12 (81)	4 (61)	2 (47)
2	2	2.5	10	125	114	106	100	75	59	49	8 (129)	6 (117)	5 (109)	4 (103)	2 (77)	2 (61)	1 (50)
3	1.5	2	5	125	114	106	98	75	59	50	10 (131)	9 (119)	7 (110)	4 (101)	2 (77)	2 (61)	2 (52)
4	1.5	1.5	5	125	114	106	98	75	59	49	22 (138)	21 (127)	12 (114)	9 (104)	3 (77)	2 (61)	2 (51)
5	2	1.5	5	125	114	106	100	75	60	49	22 (138)	18 (126)	14 (115)	9 (106)	4 (78)	3 (62)	2 (51)
6	1.5	1.5	10	125	114	106	98	75	59	49	25 (140)	21 (127)	10 (112)	9 (104)	3 (77)	2 (61)	2 (51)
7	1.5	2	10	125	114	106	98	75	59	49	11 (132)	9 (119)	6 (109)	4 (100)	2 (77)	2 (61)	2 (51)
8	2	1.5	10	125	114	106	100	75	60	49	22 (138)	18 (126)	13 (115)	8 (105)	4 (78)	3 (62)	2 (51)
9	2	2	5	125	114	106	100	75	60	49	13 (133)	10 (120)	7 (110)	5 (103)	3 (77)	2 (62)	2 (51)
10	2	2	10	125	114	106	100	75	60	49	13 (133)	9 (119)	7 (110)	5 (103)	3 (77)	2 (62)	2 (51)
11	1.5	2.5	5	125	114	106	99	75	60	49	7 (128)	6 (117)	5 (109)	3 (102)	2 (77)	2 (62)	2 (51)
12	2	2.5	5	125	114	106	99	75	60	49	8 (129)	7 (117)	5 (109)	4 (102)	2 (77)	2 (62)	2 (51)
13	1.5	2.5	10	125	114	106	99	75	60	49	7 (128)	6 (117)	5 (109)	3 (102)	2 (77)	2 (62)	2 (51)

Table 4.7 Numbers of respondents classified as excess commuters for 13 weight options (rows) and 7 saving options (columns) for a car and public transport alternatives [count].

The aim of H1 is to verify if excess commuters can be identified by their commuting behaviour. The results show that number of EC within one sample can vary as according to the methods used it depends on the parameters considered (time, cost, effort, generalised cost). Nevertheless it is possible, for the given sample, to distinguish between NEC and EC using criteria of the three travel parameters or the generalised cost formula. The pure travel time method identified a maximum of 124 EC, pure monetary cost 71 EC, pure effort various results (see Table 4.5) and generalised cost 100 EC. Interestingly, the results between the groups overlap and the majority of respondents classified as performing EC via the generalised cost method are also identified when using the pure methods for time, cost or effort (see Table 4.6). This is probably due to the complexity of the generalised formula used, which includes elements of travel time and monetary cost of travel. The generalised cost method is the most comprehensive out of the four methods used, as it uses a mathematical formula, weights for walking, waiting and interchanges as well as parameters for value of time and vehicles operating costs (for car option) tested and recommended by the Department for Transport, and is best embedded in the economic analysis of travel behaviour used in transport analysis.

It can be argued that the pure method is not realistic, as commuters generally follow a generalised cost approach and not just time, or cost, or effort in isolation (see Chapter 2 Section 2.2). However, the pure method brings a new dimension to excess commuting assessment by showing how results can vary when different parameters are considered separately. The results show that when the time is considered more EC are identified for a car option than for public transport and for cost and effort parameters the results are the opposite. This result can be explained by the limited flexibility of public transport in terms of journey time (time is fixed so time savings opportunities are limited), but some flexibility in terms of journey cost (e.g. various ticket options available) and effort (e.g. walking time and interchanges can vary between options). Moreover, the analysis shows that when time, cost and effort are all taken into account at the same time for the 20% saving option, the number of excess commuters drops down to 3 respondents. This result suggests that the generalised cost formula is taking into account some important variables that the other pure measures, even when combined, are missing.

The presented analyses suggest that H1 should be accepted, as each method identified excess commuters. However, when the three parameters of time, cost and effort were considered separately the number of EC and NEC within the three groups varied greatly. It is recommended to continue forthcoming analysis based on the 'pure' method for EC identification as well as the generalised cost method to check how analysis of results will change between the groups. The suggestion to continue with the 'pure' identification of EC is in line with previous excess commuting literature presented in Chapter 2 Section 2.4, where the majority of authors (e.g. Hamilton (1982), White (1989), Yang (2012)) focused their analyses on one of the parameters only, with time or distance parameters being most commonly used (see Table 2.1 in Chapter 2).

Results for seven different saving options were compared and it appears that the 5% saving rule offers little savings (e.g. 1.4 minutes and £0.09 savings on average) and the 50% saving rule is not realistic (e.g. 14 minutes and £0.95 savings on average). Therefore the middle saving option with 20% margin is recommended for further analysis. The next section will test the second hypothesis in the context of EC and NEC identified in terms of time, cost, effort and generalised cost using the 20% savings threshold.

4.3 Analysis of Hypothesis Two

The second hypothesis (H2) of this study is that **"**People exhibiting excess travel in their commuting behaviour can be understood through their socio-economic, lifestyle or travel attitudes", where the null hypothesis is that "Travellers exhibiting excess commuting and non excess commuting do not differ in terms of socio-economic, lifestyle and travel attitudes" (see Chapter 3, Section 3.2). This section presents and analyses responses to selected questions in the questionnaire linked to H2. The results are divided between NEC and EC, identified through time, cost, effort and generalised cost analyses using the 20% savings as the minimum threshold.

4.3.1 Socio-economic characteristics

Detailed results of socio-economic characteristics of the sample are presented in Table O.1 in Appendix O. Table 4.7 below displays results for "marital status" only, as it is the only category where results show the distribution between the different

marital status options are statistically significantly different between NEC and EC at the 95% level. The highlighted results in Table 4.7.1 show that the cost group includes 62% of EC being married against 49% of the NEC; and in terms of separated individuals there were more NEC (17%) than EC (3%).

Cate-gory	Options	Total sample n=223	Time		Cost		Effort		Generalised cost	
			NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Marital Status	Single	32	42	25	32	34	35	32	37	27
	Married	53	44	60	49	62	51	54	50	57
	Separated	12	12	12	17	3	10	13	10	14
	Widowed	2	2	2	3	1	4	2	3	1
	No response	1	0	1	1	0	0	1	0	1
	Chi-square	-	8.45		9.90		1.57		5.15	
	p-value	-	0.07		0.04		0.81		0.27	

Table 4.7.1 Marital statuses of respondents within the four groups [%]. Highlighted group with statistically significantly different results at the 95% level between EC and NEC. Pearson Chi-square test used.

4.3.2 Preferences and opinions when commuting

The questionnaire asked respondents to score their preferences and options with regards to eleven variables and 23 statements describing their travel-to-work decisions and the journey itself. The scores given for both questions were tested for normality using K-S test (see Table O.2 and Table O.3 in Appendix O) which revealed that in both cases distribution of scores was not normal, therefore non-parametric tests (Pearson Chi-square test) were used for comparing values between NEC and EC within the four groups.

The first attitudinal question asked about the importance of eleven variables when choosing travel to work. Table 4.8 displays median values of the variables and is organised in four main columns for parameters (time, cost, effort and generalised cost) and eleven rows for variables determining travel choices.

The opinions presented in Table 4.8 are not statistically significantly different at the 95% level between NEC and EC. However, it is worth noting that only three out of eleven variables (highlighted in blue) have a median of 5.00, when a 5-point Likert scale (where 1 – not important and 5 – very important) was used. This shows that the three variables: good accessibility, good safety, short time (highlighted in blue) were

equally important for the sample, whereas "curiosity of new places" (highlighted in orange) had a median of 2.00 across the four groups, which are the lowest results out of the eleven variables.

Variable	Total sample n=223			Group	Time	Cost	Effort	Genera-lised cost
	Median	Minimum	Maximum		Median	Median	Median	Median
Good Accessibility	5	1	5	NEC	5	5	5	5
				EC	5	5	5	5
Good Comfort	4	1	5	NEC	4	4	4	4
				EC	4	4	4	4
Curiosity of New Places	2	1	5	NEC	2	2	2	2
				EC	2	2	2	2
Short Distance	4	1	5	NEC	4	4	4	4
				EC	4	4	4	4
High Independence	4	1	5	NEC	4	4	4	4
				EC	4	4	4	4
Low Price	4	1	5	NEC	4	4	5	4
				EC	4	4	4	4
Good Safety	5	1	5	NEC	5	5	5	4
				EC	5	5	5	5
Short Time	5	1	5	NEC	5	5	5	5
				EC	4	5	5	5
Good Enjoyment	4	1	5	NEC	4	4	4	4
				EC	4	4	4	4
Good Health	4	1	5	NEC	4	4	4	4
				EC	4	3	4	3
Environment	4	1	5	NEC	4	4	4	4
				EC	4	3	3	3

Table 4.8 Comparison of medians for 11 variables determining travel choices, 5-point scale from 1 – not important to 5 – very important. Variables highlighted in blue with values 4.0 or over, highlighted in orange with the smallest values. Pearson Chi-square test used, no statistically significant differences between NEC and EC at the 95% level were found.

The second attitudinal group of questions asked respondents about attitudes related to 27 statements characterising travel to work and a 4-point Likert scale (where 1 – not at all true and 4 – very true) was used to mark responses. Table 4.9 presents results for statements, where values for EC and NEC within the four groups were statistically significantly different at the 95% level are highlighted in blue (detailed results for the 27 statements are available in Table O.3 in Appendix O). It can be seen that six out of eleven statements in Table 4.9 within the cost group are statistically significantly different at the 95% level. The values for NEC and EC for the statement "Sometimes I choose other route because I am curious of the new route" were identified as statistically significantly different at the 95% level also for the time group (p-value = 0.00) as well as the generalised cost group (p-value = 0.04) with median for time NEC and cost NEC being lowest than for EC in both cases

(1.00 versus 2.00). The values for NEC and EC for the statement “If I could find quicker and cheaper way I would use it” were identified as statistically significantly different at the 95% level for the time group (p-value = 0.02) and the generalised cost group (p-value = 0.07). Results for the effort parameter show statistically significant differences at the 95% level between NEC and EC for two statements describing driving with both groups disagreeing that driving offers them the sensation of speed and some pride; and for the scenic beauty statement.

Statement	Total n=223	Group	Time NEC n=98, EC n=125			Cost NEC n=152, EC n=71			Effort NEC n=49, EC n=174			Generalised cost NEC n=123, EC n=100		
	Median		Median	Pearson Chi-square	p-value	Median	Pearson Chi-square	p-value	Median	Pearson Chi-square	p-value	Median	Pearson Chi-square	p-value
Sometimes I choose other route because I am curious of the new route	2	NEC	1	15.89	0.00	1	26.41	0.00	2	1.28	0.73	2	7.92	0.04
		EC	2			2			2			2		
When I travel I have a chance to enjoy scenic beauty	2	NEC	2	0.24	0.97	2	14.59	0.00	2	8.87	0.03	2	2.90	0.40
		EC	2			2			2			2		
A travel time is a good time to relax	2	NEC	2	2.37	0.49	2	8.65	0.03	2	3.37	0.29	2	3.10	0.37
		EC	2			2			2			2		
I like exploring new places	3	NEC	3	3.65	0.30	3	18.33	0.00	3	2.63	0.45	3	8.00	0.04
		EC	3			3			3			3		
When I am travelling every day is the same	2	NEC	3	3.83	0.28	3	9.19	0.02	2	1.26	0.73	3	3.81	0.28
		EC	2			2			2			2		
We need more public transportation, even if taxes have to pay for a lot of the costs	3	NEC	3	0.28	0.96	3	15.78	0.00	3	2.18	0.53	3	0.26	0.96
		EC	3			2			2			3		
If I could find quicker and cheaper way I would use it	3	NEC	3	9.29	0.02	3	0.23	0.97	3	0.89	0.82	3	6.78	0.07
		EC	3			3			3			3		
I like to feel the sensation of speed when I am driving	2	NEC	2	7.43	0.05	2	4.21	0.23	1	7.72	0.52	2	6.85	0.07
		EC	2			2			2			2		
Driving a car gives me a feeling of pride in myself	2	NEC	2	5.09	0.16	2	2.24	0.52	1	8.04	0.04	2	4.99	0.17
		EC	2			2			2			2		
Getting here is half the fun	2	NEC	2	5.96	0.11	2	5.49	0.13	1	18.87	0.00	2	7.77	0.05
		EC	2			2			2			2		
My trip is a useful transition between home and work/destination	3	NEC	3	3.59	0.30	3	1.05	0.78	3	5.67	0.12	3	7.94	0.04
		EC	2			2			2			2		

Table 4.9 Comparison of median for NEC and EC within the four groups for selected statements characterising commuting. 4-point Likert scale from 1-not at all true to 4-very true. Highlighted items significant at the 95% level, Pearson Chi-square test used, Asymp. Sig. (2-tailed).

4.3.3 Daily travel

78% of the sample commutes five days a week, followed by 19% who travel one or "a few days a week" with the remaining 7% of the sample commuting seven days a week. As displayed in Table 4.10, 41% of the total sample drive to work and percentages of EC driving to work are much higher than NEC in all of the four groups (e.g. 44% versus 37% for the time group or 52% versus 36% for the cost group). Moreover, the distribution across the different modes between NEC and EC are statistically significantly different at the 95% level for cost and effort groups (Pearson Chi-square test results and significance levels displayed at the bottom of the table). The second most popular mode of transport to work is bus which is used by 22% of the total sample. Within the effort group there are less EC than NEC using public transport to get to work (e.g. by metro: 8% versus 10%; by bus 14% versus 49%) as nearly half of the effort EC are driving to work (45% driving and 2% as passengers in a car). This result is unexpected, and against the assumption used in the study that commuting by public transport requires more effort (based on Stradling (2002)), as in principle effort EC are identified as respondents spending more physical, cognitive and affective effort with their current commute journeys than they could have spent with the suggested alternatives, suggesting that driving to work can be more demanding than using public transport. Actually in this case within the effort group the overall number of driving EC (45%) is much higher than EC using public transport (22%) or cycling (15%). One more interesting, and statistically significantly different result at the 95% level between NEC and EC, is for the cost group where there are 19% of NEC cycling and zero EC using a bike to get to work. This result is interesting because it confirms that the pure cost classification, which is based on financial cost of travel, is appropriate as 100% of respondents who cycle to work (13% of the total sample) and do not spend money on commute are classified as NEC in the cost group (alternative options of car or public transport are not attractive to NEC as they require greater financial cost in comparison with cost-free cycling).

Work travel mode recently used	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Metro	9	10	7	10	6	10	8	7	10
Train	0	1	0	0	1	2	0	1	0
Bus, minibus, coach	22	24	20	19	28	49	14	23	21
Driving a car or van	41	37	44	36	52	27	45	37	45
Passenger in a car/van	1	3	0	2	0	0	2	2	0
Bicycle	13	14	12	19	0	6	15	17	8
On foot	6	6	6	9	0	4	7	7	6
Other	6	4	12	5	11	2	10	6	10
Total [%]	100	100	100	100	100	100	100	100	100
Chi-square	-	14.84		36.29		34.74		18.13	
p-value	-	0.25		0.00		0.00		0.11	

Table 4.10 Mode of transport used for the last self-reported travel to work journey [%]. Highlighted groups with statistically significantly different results at the 95% level between EC and NEC, Pearson Chi-square test used, Asymp. Sig (2-sided).

85% of households surveyed own a car and 80% of respondents hold a drivers' licence, which suggests that there are households with cars within the sample where respondents are not the owners or users of the car. Table 4.11 displays the percentage of respondents owning a car for individuals with drivers licence only and shows that within the time, effort and generalised cost groups more EC than NEC own a car. Overall, statistically significant differences between NEC and EC at the 95% level occur for time and generalised cost groups (highlighted in Table 4.11) with more than a half of time EC with driver licence owning one car (54%) against a quarter of NEC with a one car (27%). The results for 2-car households are also greater for EC within the time (34% versus 22%) and generalised cost (38% versus 21%) groups than for NEC.

Number of Cars or Vans in Household	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
None	4	8	0	5	1	6	3	7	0
1 car	42	27	54	46	32	35	44	37	48
2 cars	29	22	34	24	38	14	33	21	38
3 cars	4	4	5	4	6	0	6	3	6
4 cars or more	1	1	1	1	1	2	1	1	1
No response	0	0	1	1	0	0	1	0	1
Total of driver licence holders within the groups	80%	62%	94%	80%	79%	57%	86%	68%	94%
Chi-square	-	17.87		7.81		8.25		11.22	
p-value	-	0.00		0.16		0.14		0.04	

Table 4.11 Percentage of respondents within the four groups with cars or vans in households being driving licence holders. Highlighted groups with statistically significantly different results at the 95% level between EC and NEC. Pearson Chi-square test used.

74% of the total sample use the same route to work every time they commute, where the same mode of transport is used on a regular basis by 61% respondents (see Appendix O Table O.6 and Table O.7). What is interesting is the percentage of respondents who do not always take the same route (26%) or mode (30%) for commuting implying that they do have alternative routes and/or modes available and that they use them. This observation might be important for identifying EC, as it shows that on different days some respondents may use different modes of transport or routes.

The self-reported data shows that for the sample it is more common to use the same transport route than the same transport mode, which is reasonable assuming respondents have one origin-destination route only and different transport modes (e.g. car, bus, bike) to choose from. However, in reality travel routes will probably vary by mode as well (e.g. a car journey offers flexibility in choosing a route from A to B when a bus route is restricted to the schedule). The above results are not statistically significantly different between NEC and EC at the 95% level.

When these results are further filtered by mode of transport recently used, it appears that some differences between commuters using a car and non-car travel options occur, although they are not statistically significantly different at the 95% level (see Table O.8 and O.9 in Appendix O for details). Amongst NEC, within the four groups, more non-car commuters (e.g. public transport users) than car commuters are using the same route every day. Results for using the same mode every day are higher amongst NEC for non-car users than car commuters, and amongst EC higher for car drivers than non-car commuters. This might be explained by the fact that the transport mode used for commuting determines the flexibility of travel to work route with a car being a more flexible option than a bus or metro (the latter two have fixed stops).

4.3.4 Activities conducted while commuting

Respondents conducted a variety of activities while commuting. Table 4.12 highlights the results, which are statistically significantly different at the 95% level between EC and NEC (detailed results are in Table O.5 in Appendix O). It can be seen that "listening to music/radio" is a very popular activity with 58% of the sample undertaking it, but the only statistically significantly different results for this activity between NEC (53%) and EC (70%) at the 95% level are for the cost group.

Within the cost group more EC than NEC self-reported that they read newspapers (31% versus 19%) while commuting, but more NEC than EC declared doing some physical exercises (e.g. walking) while commuting (26% versus 6%). In contrast, within the effort group fewer EC than NEC read books (17% versus 31%) or newspapers (19% versus 37%) on their journey to work, but nearly a quarter of EC (23%) do some physical exercises instead. Overall 50% of the sample stated that they concentrate on the road while commuting, but statistically significant differences at the 95% level between NEC and EC occur within time and effort groups only and in both cases results are higher for EC than for NEC (58% versus 40% for the time group and 57% versus 27% for the effort group). This might be caused by the fact that the proportion of EC driving to work within the time group as well as the effort group is higher that the proportion of driving NEC within the same groups.

Parameter	Group	Activities Conducted When Travelling to Work					
		Listen to music/ radio	Read books	Read news-papers	Exercise	Concen-trate on the road	Other
Time	NEC n=98	61	27	26	17	40	2
	EC n=125	56	15	21	22	58	3
	Chi-square	0.61	4.37	0.69	0.62	7.60	0.28
	p-value	0.43	.036*	0.40	0.42	.00*	.59a
Cost	NEC n=152	53	18	19	26	49	1
	EC n=71	70	25	31	6	54	7
	Chi-square	6.301	1.73	3.89	13.07	0.45	7.53
	p-value	.012*	0.18	.04*	.00*	0.50	.00a*
Effort	NEC n=49	49	31	37	8	27	4
	EC n=174	61	17	19	23	57	2
	Chi-square	2.242	4.24	6.84	5.30	14.10	0.46
	p-value	0.13	.03*	.00*	.02*	.00*	.49a
Generalised cost	NEC n=123	59	22	23	21	45	2
	EC n=100	57	18	23	18	57	4
	Chi-square	0.12	0.53	0.00	0.34	3.33	1.18
	p-value	0.72	0.46	0.96	0.55	0.06	.27a
Total sample n=223		58	20	23	20	50	3

Results are based on nonempty rows and columns in each innermost subtable.
a. More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.
*. The Chi-square statistic is significant at the 0.05 level.
Table 4.12 Percentage of respondents within groups conducting various activities while commuting (more than one answer option available) [%]. Highlighted items significant at the 95% level, Pearson Chi-square test used.

4.3.5 Teleportation test

To test respondents' willingness to change transport modes, a question regarding teleportation was asked. The additional purpose of this question was to show respondents' reasons for and against teleportation, which might in turn be interpreted as general reasons for and against current/future transport modes' usage (see Section 3.3.2.2).

Statistically significantly different results at the 95% level between NEC and EC were identified for two reasons only: “hate commute” reason within the effort group (14% versus 5%) and “like to exercise” reason within the cost group (13% versus 3%) and these are displayed in Table 4.13.

If you could arrive at your work without commuting would you like to do so? (e.g. use teleportation)	**Selected reasons for being a teleportation fan/ sceptic**	**Cost parameter**				**Effort parameter**			
		NEC n=152	**EC n=71**	**Chi-square**	**p-value**	**NEC n=49**	**EC n=174**	**Chi-square**	**p-value**
YES (Teleportation Fans)	Hate commute	7	7	0.00	0.95	14	5	4.76	.02a*
NO (Teleportation Sceptics)	Like to exercise	13	3	5.69	.01*	6	11	0.91	.33a
Results are based on nonempty rows and columns in each innermost subtable. * The Chi-square statistic is significant at the .05 level. a More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.									

Table 4.13 Percentage of NEC and EC within the two groups being “for” and “against” teleportation [%]. More than one answer option available. Highlighted items significant at the 95% level, Pearson Chi-square test used.

The main reasons for being keen on arriving at work without commuting by teleportation fans would be time savings (40% of the total sample), followed by savings in money and effort (15% and 13%, respectively), supported by an imaginative answer “Just to try it” (17%) (detailed results in Table O.8 in Appendix O). All the other reasons for being ‘for’ or ‘against’ teleportation, based on money, effort and curiosity grounds were not statistically significantly different and their results are reported in Table O.8 in Appendix O. Although the reason for time saving was an expected answer for respondents classified as teleportation fans, as this form of transport would limit time needed for travel, a marginal importance of money (17% or less) and effort (20% or less) savings is a surprise. Also the popularity of “hate commute” reason amongst effort NEC is unexpected, as this reason did not get more attention amongst the other three groups (between 6% and 9%).

4.3.6 Money and time savings results

After investigating attitudes towards teleportation, respondents were asked questions about willingness to change from the current to a different transport mode, questions that considered money and time savings. Table 4.14 displays results for the four groups, where it is clearly seen that time savings are more common responses amongst the majority of the sample (58%) than costs savings (42%). Statistically significant

differences at the 95% level between NEC and EC occurred for the cost and the effort groups in the journey cost ("less expensive") context (highlighted in blue) with higher results for cost EC (49%) than for effort EC (37%). In the journey time ("quicker") context only the cost group's results for both "Yes" and "No" answers are statistically significant different between NEs and EC.

Alternative Journey Used if		Total sample n=223	Time		Cost		Effort		Generalised cost	
			NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Less Expensive	No	35	38	32	32	39	24	37	37	32
	Yes	42	44	41	39	49	59	37	41	44
	No response	23	18	27	29	11	16	25	23	24
	Chi-square	-	2.48		8.47		7.47		0.51	
	p-value	-	0.28		0.01		0.02		0.77	
Quicker	No	35	34	35	39	24	27	37	35	34
	Yes	58	63	54	51	75	69	55	60	56
	No response	7	3	10	10	1	4	8	5	10
	Chi-square	-	4.90		12.98		3.32		2.19	
	p-value	-	0.08		0.00		0.19		0.33	

Table 4.14 Willingness amongst the sample and the groups to choose new alternative journey when less expensive and quicker options are considered [%]. Highlighted groups with statistically significantly different results at the 95% level between EC and NEC. Pearson Chi-square test used.

Table 4.15, which presents more detailed results, showing that 21% of respondents would choose an alternative journey if it was cheaper by £1, followed by 24% who would be willing to swap in order to save between £1.50 and £3.00 on a single trip to work. In terms of travel time savings, as little as a five minute saving would encourage 12% to switch to the alternative journey. A 10-minute saving, however, would attract a further 24% and a 15 minute saving an additional 23%, giving a total of 59% of the sample interested in savings between 10-20 minutes. It must be pointed out here that taking into account the average commute time for the sample, which is 28 minutes, savings of 20 minutes on a one-way commute journey are unlikely in reality, although might be possible on an individual basis for respondents with a large self-reported travel time. The only group presenting statistically significant differences at the 95% level between NEC and EC is the cost group where globally 75% of EC and 55% of NEC would use an alternative journey if it was cheaper. The results also show that 24% of EC and only 7% of NEC would use alternative if it offered them £2 savings, but this result is not realistic for the total sample where the average cost of one-way commute is £2.18. In general, the results in all groups are higher for EC compared to NECs for cost as well as time savings which suggests that it would be slightly easier to convince EC than NEC to choose new commute options by offering cheaper (£1) and quicker (10 minutes) alternatives. In a sense this might be expected because cost NEC are already

cost minimisers, as their self-reported financial cost of commuting is smaller than the cost offered by the alternative options.

Alternative Journey Used if		Total sample n=223	Time		Cost		Effort		Generalised cost	
			NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Less Expensive by	50p	16	15	16	20	6	20	14	14	18
	£1	21	20	22	18	27	24	20	20	23
	£1.50	4	8	2	4	6	6	4	7	2
	£2	12	12	12	7	24	10	13	13	11
	£2.50	3	3	2	1	6	4	2	3	2
	£3	5	5	5	4	7	4	5	5	5
	Total %	61	64	58	55	75	69	59	61	61
	Other	16	16	16	16	15	20	15	16	16
	No response	23	19	26	29	10	10	26	23	23
	Chi-square	-	6.36		32.70		7.45		3.93	
	p-value	-	0.49		0.00		0.38		0.78	
Quicker by	5 mins	12	14	10	14	7	4	14	12	11
	10 mins	24	24	24	25	23	24	24	24	24
	15 mins	23	24	22	21	27	24	22	23	23
	20 mins	9	8	10	8	13	14	8	9	10
	30 mins	7	6	7	4	13	8	6	5	9
	Total %	75	78	73	72	82	76	75	73	77
	Other	18	18	18	19	17	16	19	20	17
	No response	7	4	9	9	1	8	6	7	6
	Chi-square	-	3.44		13.87		5.27		1.86	
	p-value	-	0.75		0.03		0.50		0.93	

Table 4.15 Readiness to choose new alternative journey [%]. Highlighted groups with statistically significantly different results at the 95% level between EC and NEC. Pearson Chi-square test used.

4.3.7 Summary

The analyses presented in this section show that in light of H2, which says that "People exhibiting excess travel in their commuting behaviour can be identified through their socio-economic, lifestyle or travel attitudes", a limited number of statistically significant differences between NEC and EC at the 95% level was identified within the four groups. Out of the four groups the cost group scored most of the statistical differences at the 95% level between NEC and EC (seven cases out of nine tests presented in Tables 4.9–4.15 in this section) suggesting that differences between NEC and EC within this group are more visible than within the other three groups. For example, the analysis presented in this section showed that cost EC are more likely to be married (62% of EC versus 49% of NEC), and enjoy their commute time (relax or reset for work). Also, cost EC are less likely to complain about (boring, hassle etc.) commuting when over half of them travel by car (52% of EC) and only a third by public transport (28% by bus and 6% by metro). Cost EC are more likely to use alternative journey options, if these were only less expensive (49% for EC and 39% for NEC) or quicker (75% for EC and 51% for NEC).

Although other differences between NEC and EC, which were statistically significant at the 95% level, occurred within the other three groups, the characteristics of cost parameter group are most clear out of the four. Overall, H2 is accepted for the cost group but rejected for the other groups, as the analysis presented in this section did not provide an argument that NEC and EC are different with regards to time, effort or generalised cost consistently over all parameters although there is evidence of some differences. Therefore the null hypothesis, which states that EC and NEC do not differ in terms of socio-economics, lifestyle and travel attitudes, is not consistently rejected for this sample.

4.4 Analysis of the Third Hypothesis

The third hypothesis H3 is that "There is a relationship between the factors that influence travel choice and the propensity for excess travel", with the null hypothesis being that there is no relationship (see Chapter 3, Section 3.2). In other words H3 requires an investigation of the differences between the travel choice factors of NECs and ECs. This section compares responses from NECs and ECs for time, cost, distance and effort spent on commuting. The section also includes results linked to knowledge about transport planning tools and sources of travel information as those contribute to a better understanding of the sample, and the extent to which respondents travel choices are informed.

4.4.1 Alternative commute journeys

Section 4.3.3 described the transport modes currently used by respondents. Respondents were asked to describe the alternative modes available to them for commuting journeys (Table 4.17). The results show that respondents are aware of alternative transport options with only 8% of respondents not being aware of any alternatives. 50% of the sample identified public transport as an alternative to their current mode of transport to work (13% for Metro, 3% for train and 34% for a bus), with the differences between NEC and EC being statistically significantly different at the 95% level for only one out of the four groups. 17% of respondents specified a car as their alternative (11% as drivers and 6% as passengers), but within the time group only 3% of NEC and 17% of EC saw a car as their alternative. 18% of the sample would consider cycling or walking to work. Only the time group overall shows statistically significantly different results at the 95% level between NEC and EC for alternative modes. Time differences are more likely to be driven by mode selection and this group, at the division between NEC and EC, are obviously sensitive to this.

Self-reported transport alternative for travel to work	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Metro	13	10	15	13	14	8	14	15	11
Train	3	3	2	1	6	4	2	3	2
Bus	34	33	35	35	32	27	36	31	38
Motorcycle	2	1	2	2	1	0	2	1	3
Driving a car	11	3	17	11	11	10	11	6	17
Passenger in a car	6	8	5	6	7	12	5	7	6
Taxi	1	1	2	1	3	4	1	1	2
Bicycle	9	11	6	6	14	10	8	10	7
No response	1	2	1	1	1	0	2	2	1
On foot	9	12	6	13	0	6	9	11	5
Other	4	4	3	3	4	4	3	3	4
No alternative	8	11	6	9	6	14	6	11	4
Pearson Chi-square test	-	19.84		18.967		15.36		17.423	
p-value	-	.04 *b		.06 b,c		.16 b,c		.09 b	

Results are based on nonempty rows and columns in each innermost sub-table.
* The Chi-square statistic is significant at the .05 level.
b More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.
c The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid

Table 4.16 Transport mode alternatives considered as an option by respondents for their current commuting journeys [%]. More than one answer option available. Highlighted groups with statistically significantly different results at the 95% level between EC and NEC. Pearson Chi-square test used.

Reasons for not using alternative transport modes vary (see Part 1 Question 6 in Appendix F). Table 4.17 presents three reasons, which are statistically significantly different between EC and NEC at the 95% level, why alternatives are not chosen and distinguishes the results between NEC and EC within the four groups. Overall, the majority of the sample perceives their alternatives as more time consuming (56% of the total sample). 27% of the overall sample, and between 28% and 38% of EC in all groups, state that they need flexibility in choosing their transport mode, which their potential transport alternatives are perceived not to offer. The two reasons given least frequently for not using alternatives (see Table O.15 in Appendix O) were because of a generally negative attitude towards public transport (scores for public transport dislike: 8% of the total sample, but only 4% of the effort NEC group) and the fact that the alternatives might be bad for the environment (for example, 10% EC for time and cost groups). Also, given Table 4.17 only shows statistically significant differences between NEC and EC, it is interesting that time group is highlighted in the “parking problems” reason only.

Reason Why Alternative Transport Modes Not Used	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
More time consuming	56	58	54	58	51	43	59	59	52
Pearson Chi-square test	-	0.46		1.01		4.13		0.95	
p-value	-	0.49		0.31		.042		0.32	
Parking problems	14	4	22	14	14	10	16	10	20
Pearson Chi-square test	-	14.99		0.006		0.87		4.70	
p-value	-	.00		0.93		0.34		.03	
Need of flexibility	27	21	31	22	38	22	28	22	33
Pearson Chi-square test	-	2.66		6.55		0.63		3.42	
p-value	-	0.10		.010		0.42		0.06	

Table 4.17 Selected reasons why alternative transport mode not used [%]. More than one answer available. Highlighted results statistically significantly different at the 95% level between EC and NEC. Pearson Chi-square test used.

4.4.2 Time and cost savings

One-way travel to work times range within the sample between 3 and 90 minutes (Table 4.18), with a median of 25 minutes. Self-reported ideal one-way travel time, which is the ideal amount of time respondents would like to spend commuting, is slightly lower than the actual time with a median of 20 minutes for NEC and EC in all the groups. A median for one-way travel cost is £1.60 for the sample. However, as mentioned in Sections 4.2.1 and 4.2.2, the data is not normally distributed. Differences between NEC and EC are evident for the three groups of time, cost and generalised cost, where EC spend on average more time and more money on their daily commute than NEC from the same three groups. In terms of commuting distance, NEC travel further than EC in three out of four groups (an exception for the cost group where EC travel much further than NEC) and their distance is over 10 kilometres one-way. The results presented in Table 4.18 however, are not statistically significantly different between NEC and EC within the four groups suggesting that NEC and EC share similar time, ideal time, cost and distance parameters for commuting.

Variable [unit]	Option	Total sample n=223	Time		Cost		Effort		Generalised cost	
			NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Total Travel Time [mins]	Median	25.0	20.5	27.0	24.5	35.0	30.0	25.0	24.0	27.0
	Minimum	3.0	3.0	5.0	3.0	10.0	5.0	3.0	3.0	5.0
	Maximum	90.0	90.0	85.0	65.0	90.0	90.0	85.0	90.0	85.0
	Pearson	-	49.97		77.65		50.80		60.40	
	p-value	-	0.31		0.00		0.29		0.07	
Ideal One-way Travel Time [mins]	Median	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	Minimum	5.0	5	5	5	10	5	5	5	5
	Maximum	60.0	45	60	45	60	45	60	45	60
Total Travel Cost [£]	Median	1.6	1.5	1.8	1.5	1.9	1.8	1.5	1.5	1.8
	Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Maximum	10.5	8.0	10.5	10.5	10.0	8.0	10.5	8.0	10.5
	Pearson	-	49.13		59.48		74.32		49.60	
	p-value	-	0.66		0.28		0.03		0.64	
Total Travel Distance [km]	Median	8.4	9.0	8.0	7.9	11.7	9.3	8.2	8.9	7.8
	Minimum	0.2	0.9	0.2	0.2	2.4	0.2	0.9	0.9	0.2
	Maximum	48.0	33.2	48.0	48.0	40.4	48.0	38.9	48.0	38.9

Table 4.18 Time, cost and distance values for NEC and EC within the four groups [count]. Highlighted results statistically significantly different at the 95% level between EC and NEC. Pearson Chi-square test used.

4.4.3 Physical effort spent when commuting

Effort spent on commuting is the third parameter analysed in the context of excess commuting. The questions regarding physical effort in the questionnaire considered effort spent on walking, waiting and carrying goods. In addition, overall effort is compared against these three components. None of the results were statistically significantly different between NEC and EC at the 95% level, which suggests that perception of physical effort is not statistically significantly different across the sample (see Figure O.1 in Appendix O). The majority of respondents (around 60%) representing both NEC and EC within the four groups think that the amount of physical effort spent when commuting is "about right". Some differences, occur between the attitudes expressed by respondents towards walking, waiting and carrying goods when commuting. Between 20% and 30% of respondents within the four groups think that there is "too little" or "far too little" walking in their daily commute. At the same time, between 21% and 35% of the sample thinks that there is "too much" or "far too much" waiting involved in their travel to work. Between 18% and 22% of the respondents within the sub-groups agree that they are carrying "too much" or "far too much" (e.g. personal bags, lunch package, books) to work. Finally, the overall effort spent on daily commuting is perceived as "about right" by between 71% and 81% of the respondents within the groups.

4.4.4 Cognitive effort

The majority of the sample (67%) do not put extra effort into planning their commute journeys and only 30% of the total sample plan their journey to work in advance (see Table O.11 in Appendix O). The results for NEC and EC are not significantly different at the 95% significance level across the four groups.

The 'planners' identified a number of activities they usually spent time on before the journey, (Table O.12 in Appendix O), and those include actual route, time or mode planning, as well as, for example packing their bags. The most common activities are related to packing bags (lunch, clothes for change, keys etc.) or checking transport mode and route (checking car/bike, congestion etc.). Only 6% of the total sample mentioned that they focus on entertainment activities and remember to take their ipad, a book or a newspaper with them. The results for NEC and EC for this activity vary between cost and effort parameters, where within the cost group EC (14%) are more focused on entertainment than NEC (3%), but it is the opposite within the effort group (5% EC versus 10% NEC). In addition, 3% of the respondents (including commuters by bike) mentioned checking weather conditions before starting their journeys.

4.4.5 Affective effort

Affective effort in the context of the survey questions is about stress (see Part 1 Questions 17 and 18 in the questionnaire in Appendix F) stress is proxied by whether commuters check progress when on a commuting journey in the first question. 53% of the respondents agreed that they do check their progress, but overall the results are at the same level between the four groups as well as between NEC and EC and are not statistically significantly different at the 95% significance level (see Table O.13 in Appendix O).

The next question related to the reasons why respondents found their journey to work stressful, with suggested answers of being late and being worried about personal safety (Table 4.19). Although most of the sample (70% and 77%, respectively) did not answer these questions, the respondents who answered cited the reason of being late for work (between 11% and 27% for sub-groups) more than personal safety (between 0 and 11% for sub-groups). Moreover, the results are statistically significantly different within three out of four groups and are larger for EC (between 19% for effort EC and 27% for

cost EC) in all of the four groups. Only 9% of the sample expressed a concern about their personal safety when commuting therefore this issue is not discussed here.

Reason why commuting stressful	Answer options	Total sample n=223	Time		Cost		Effort		Generalised cost	
			NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Stressful being late	No	13	15	10	12	14	8	14	15	10
	Yes	17	10	23	13	27	12	19	11	26
	No response	70	74	66	75	59	80	67	75	64
	Chi-square	-	6.87		7.05		2.78		9.37	
	p-value	-	0.03		0.02		0.24		0.00	
Worried about personal safety	No	15	17	13	13	18	14	15	15	15
	Yes	9	6	10	7	11	0	11	7	10
	No response	77	77	77	80	70	86	74	78	75
	Chi-square	-	1.94		2.32		6.03		0.53	
	p-value	-	0.37		0.31		0.04		0.76	

Table 4.19 Reasons why the respondents perceive travel to work as stressful [%]. Highlighted results statistically significantly different at the 95% level between EC and NEC. Pearson Chi-square test used.

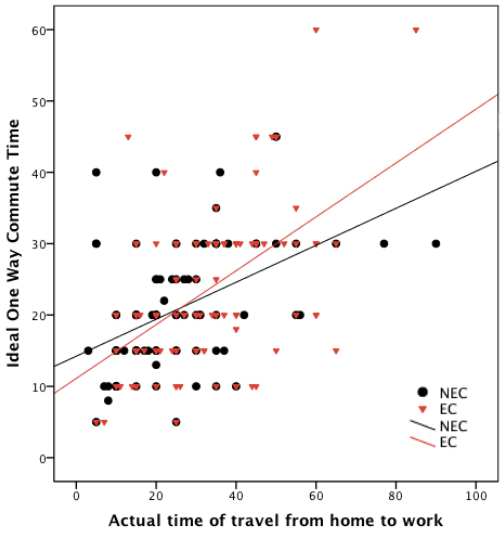
4.4.6 Perceived self-reported versus ideal commute time

A relationship between perceived self-reported one-way commute time and ideal one-way commute time was investigated in the analysis. The ideal one-way commute time is the amount of time respondents would like to spend on getting to work (see Part 2 of the questionnaire in Appendix F). Surprisingly, none of the respondents said that 0 minutes would be an ideal solution. Table 4.20 presents results for ideal one-way commute time divided into eight time categories from 5 minutes up to 60 minutes. Globally these results are not statistically significantly different at the 95% level between NEC and EC within the groups. However, the majority of respondents specified that their ideal one-way commute time is between 15 and 30 minutes. This finding is in line with Mokhtarian and Salomon (2001) who found ideal commute time for their sample to be 17 minutes. The reasons why respondents stated their ideal travel time above zero are most likely the benefits they see in commuting, such as switching on/off from work by reading newspapers or thinking.

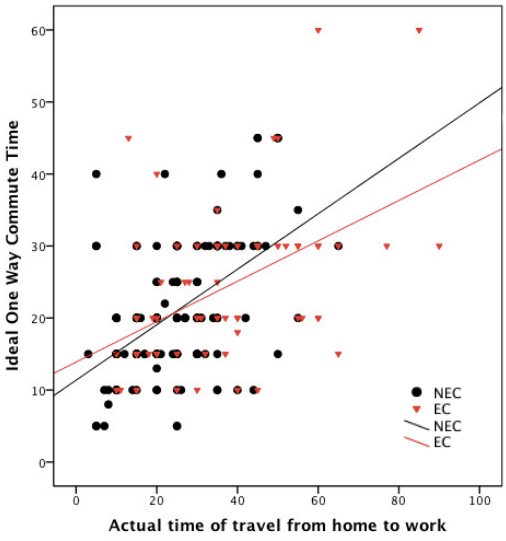
Ideal one-way commute time [minutes]	Time		Cost		Effort		Gen Cost	
	NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
5	2	1	2	0	2	1	2	1
10	13	12	13	11	6	14	12	13
15	26	20	24	18	24	22	26	18
20	24	28	28	24	27	26	26	27
30	29	30	26	37	31	29	26	33
40	4	3	4	3	4	3	5	2
50	2	5	3	4	6	3	3	4
60	0	2	0	3	0	1	0	2
Chi-square	4.57		9.14		4.19		6.53	
p-value	.71		.24		.75		.47	

Table 4.20 Ideal one-way commute time amongst NEC and EC within the four groups [%]

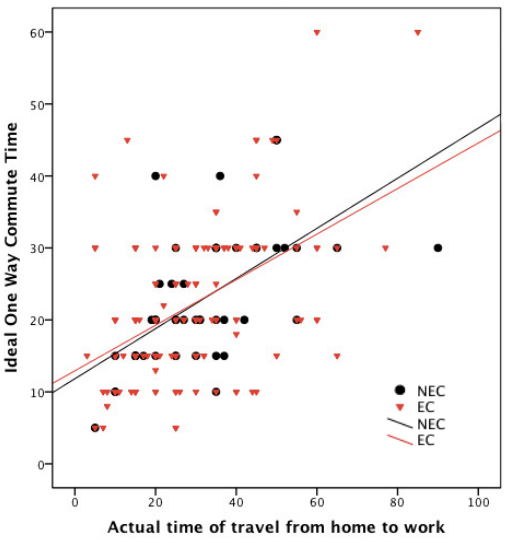
The results in Figure 4.1 show that most of the perceived self-reported commute times as well as ideal commute times have generally low values. There are a couple of outliers (top right corner on Figure 4.2) which are extreme values for both perceived and ideal commute times and both are classified as EC in all of the four groups (with values of 90 mins. versus 60 mins. and 60 mins. for both).



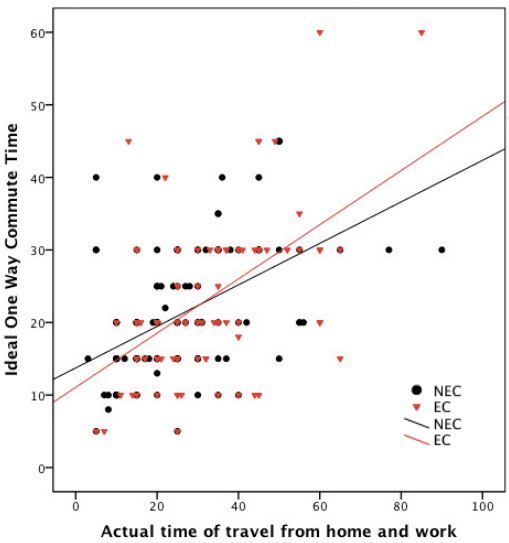
NEC: R^2 Linear = 0.221, n=98
EC: R^2 Linear = 0.296, n=125
a) time parameter



NEC: R^2 Linear = 0.271, n=151
EC: R^2 Linear = 0.240, n=71
b) cost parameter



NEC: R^2 Linear = 0.352, n=49
EC: R^2 Linear = 0.244, n=174
c) effort parameter



NEC: R^2 Linear = 0.242, n=123
EC: R^2 Linear = 0.293, n=100
d) generalised cost

Figure 4.1 Scatterplots showing relationships between actual time of travel from home to work and ideal one way commute time within four groups: a) time parameter; b) cost parameter; c) effort parameter; d) generalised cost.

R^2 values between NEC and EC in the sub-groups, generally fall between 0.221 and 0.352. Field (2009) states that values of R^2 below 0.2 are typically considered weak,

between 0.2 and 0.4, moderate, and only values above 0.4 are strong. Therefore NEC and EC in the groups show moderate positive correlation between actual and ideal one-way commute time. It can be seen that ideal journey times are generally lower than actual self-reported commute times.

4.4.7 Transport planning tools

Understanding people's knowledge about transport planning tools, as well as understanding other factors such as cost, car availability etc., is important for interpreting their travel behaviour and for planning future transport campaigns targeting the general public.

In the questionnaire respondents were asked to specify if they knew of any of the following transport planning tools: Smarter Choices, Car Share Scheme, car clubs, any workplace travel plan, Transport Direct website, Google maps, or other. In addition, data about sources of information on the planning tools was collected. Responses for the four groups are shown in Figure 4.2.

The respondents were most aware of the 'car share scheme', which was ticked on the questionnaire by a minimum of 65% (effort NEC) and a maximum of 81% (time EC) of the groups. It is suspected that this result highlights the Car Share Scheme promoted by Newcastle City Council amongst their employees, who form the majority of the sample (n = 142). The scheme is supported by the Council and employees get benefits from joining the scheme such as access to parking spaces.

The second tool that the respondents are most aware of is 'Google maps' with a minimum of 41% (effort NEC) and a maximum of 71% (effort EC). The respondents are least aware of the Transport Direct website (e.g. within the effort sub-group only 9% of EC and 22% of NEC) and the concept of 'smarter choices' (maximum awareness within the generalised cost group with 8% of EC). Also, more respondents know about car clubs (between 22% for effort NEC and 30% for cost EC) than about any workplace travel plans (between 17% for EC and 37% for NEC within the effort group). The only statistically significant differences at the 95% level occur between NEC and EC within the effort group (bold and underlined results on Figure 4.2). It can be seen on Figure 4.2 that the majority of effort EC know about the Car Share Scheme (80%) and Google

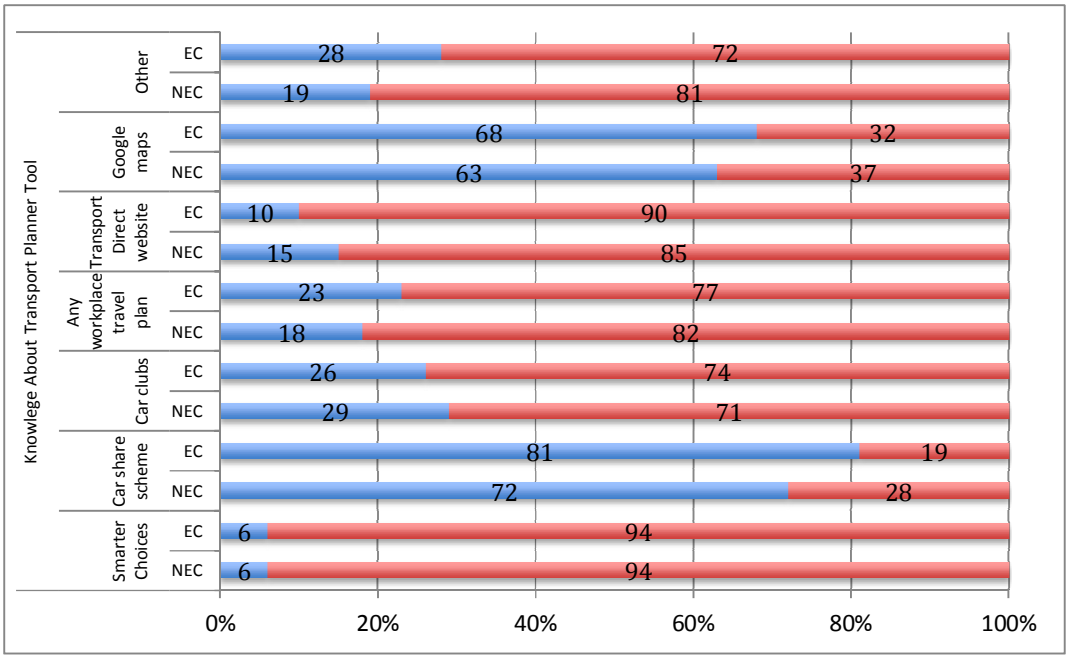
maps tool (71%), which is a much higher result than amongst effort NEC (65% and 49%, respectively).

The respondents were asked to specify sources where they have heard about the transport planning tools listed above and answer options included workplace, TV, Internet, Traveline, newspaper, flyer and other. The results between NEC and EC within the four groups are not statistically significantly different at the 95% level suggesting that the transport planning tools awareness amongst NEC and EC is similar (e.g. high for the Internet and workplace as sources of information about car share scheme or Google Maps, low for tools such as Traveline and flyers; see details on Figure O.2 in Appendix O).

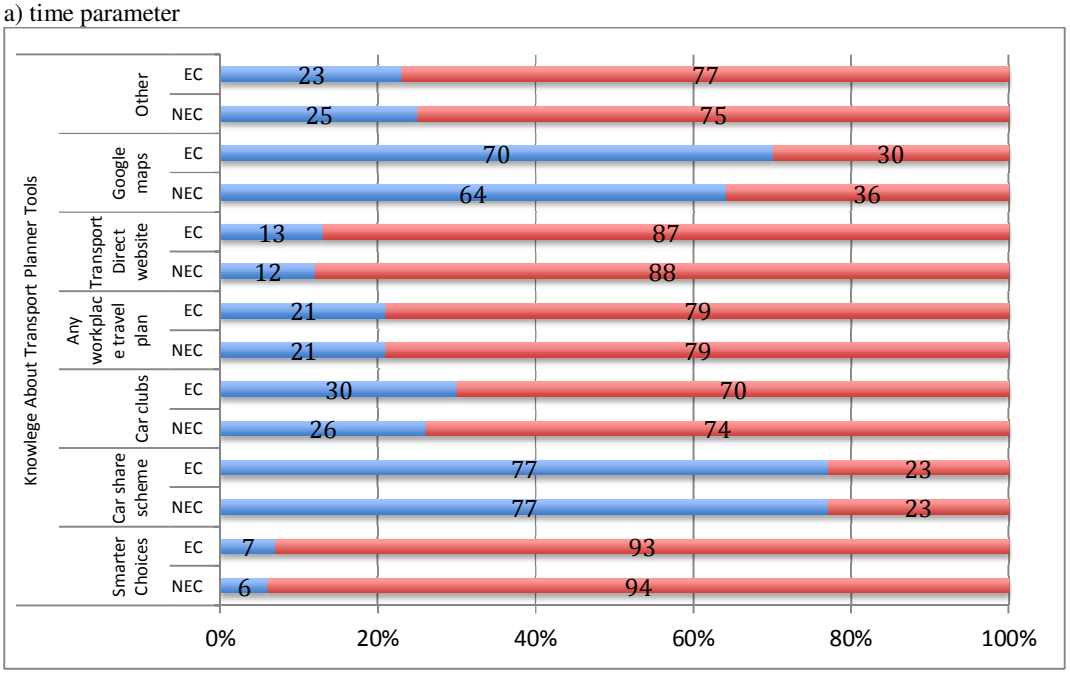
4.4.8 Summary

This section has presented different analyses conducted in the context of H3, which highlighted a moderate positive correlation between actual and ideal commute time. Overall many respondents are aware of existing transport alternatives, as expected for the commuting journey (which often is the most journey). The only statistically significant differences at the 95% level between NECs and EC occurred for the time group. The reasons why transport alternatives are not used for commuting vary between NEC and EC. Analysis of commuting effort revealed that a quarter of ECs are stressed that they will be late for work and results for NEC are much lower than for EC (the differences for time, cost and generalised cost groups were statistically significantly different at the 95% level) and this result was similar across the parameters' groups. The perception of effort that NECs and ECs spend on travelling to work and knowledge about transport planning tools and sources of information they have received is equal across the sample.

The identified similarities between NEC and EC do not allow for saying that NEC and EC have no differences. Although some results between NEC and EC vary significantly it is difficult to draw a clear picture of relationships between different factors influencing travel choices and the tendency for commuters to be classified as EC. The results hint that time and effort parameters have a role to play in EC identification, but there is not enough evidence for accepting H3 unconditionally.



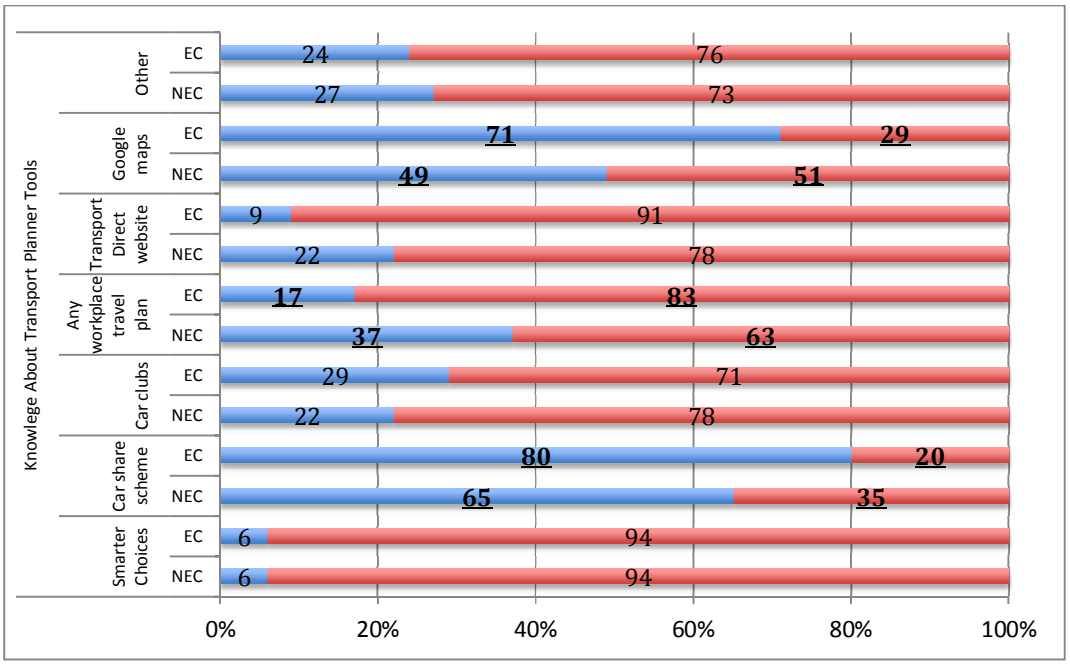
a) time parameter



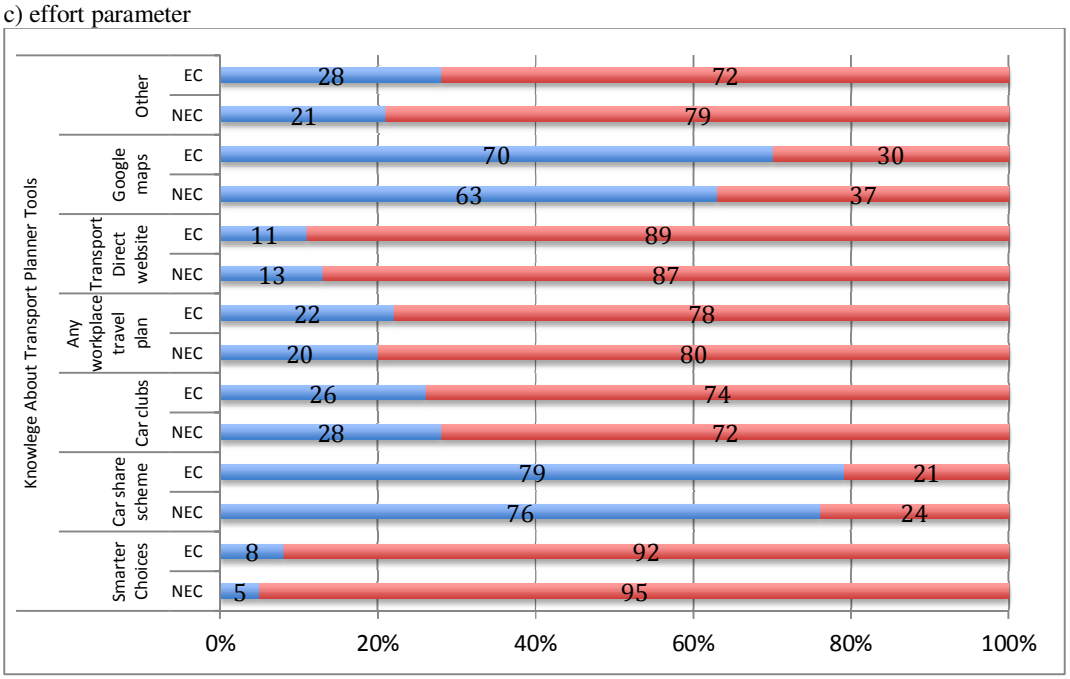
b) cost parameter

Blue – YES; **Red** – NO

Figure 4.2 Sources of information about transport planner tools within the four groups [%]. None of the data statistically significantly different between NEC and EC at the 95% significance level.



c) effort parameter



d) generalised cost

Blue – YES; **Red** – NO

Figure 4.2 Sources of information about transport planner tools within the four groups [%]. Data labels displayed in bold for statistically significant differences between NEC and EC at the 95% significance level.

4.5 Commuters opinions about public transport

The questionnaire asked respondents to express their opinions about public transport services in the context of commuting. The aim of this was to identify factors, such as safety, reliability or staff friendliness as well as demand for specific activities while commuting, which could help to increase public transport usage.

One of the questions in the questionnaire asked about ways of attracting respondents to use public rather than private transport. In this question, where respondents were asked to mark the three most important reasons for not using public transport (Table 4.21), most of results are not statistically significantly different at the 95% significance level between NEC and EC. The only exception is within the time group for "Upgraded vehicles", which as an answer was more popular amongst ECs (11%) than amongst NECs (3%). Overall, as presented in Table 4.21 below, the three most popular reasons which might encourage the respondents to consider using public transport more often are: more direct routes (53% for the sample), regular and reliable service (57%) and cheaper fares, with the last factor achieving the highest scores (between 56% and 68% in the sub-groups) out of the ten factors.

Reasons why respondents would use public transport more	**Total sample n=223**	**Time**		**Cost**		**Effort**		**Generalised cost**	
		NEC n=98	**EC n=125**	**NEC n=152**	**EC n=71**	**NEC n=49**	**EC n=174**	**NEC n=123**	**EC n=100**
More direct routes	53	54	52	49	61	45	55	54	51
Safe bus stops	7	8	6	6	8	6	7	8	5
Up-to-date timetables	13	14	12	13	13	14	13	14	12
Oyster card	13	11	14	13	14	14	13	13	13
Upgraded vehicles	8	3	11	6	11	10	7	5	11
Chi-square	-	5.16		1.96		0.59		2.93	
p-value	-	0.02		0.16		0.44b		0.87	
Regular/reliable service	57	54	58	56	58	57	56	54	60
Friendly staff	14	16	12	15	11	20	12	15	13
Cheaper fares	60	56	63	57	68	57	61	58	63
Subsidy	9	8	10	7	14	8	9	7	11
Other	2	2	2	2	1	0	2	2	1

b. More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.

Table 4.21. Factors that could encourage respondents to use public transport services more often instead of private transport [%]. Highlighted items significant at the 95% level. Pearson Chi-square test used.

Approximately a quarter of respondents within the groups (a minimum of 20% for effort NEC and a maximum of 31% for cost EC) had permanently changed their transport mode to work in the last three years and the reasons for the change included answers such as “current option cheaper”, “need a car at work” or “fitness/health” purposes (see details in Appendix O Table 16). However, none of the above results for NEC and EC are statistically significantly different at the 95% level.

The respondents stated in the questionnaire a number of activities they would like to do while commuting (multiple answers were permitted) the results of which are shown in Table 4.22. The three most desired activities were listed as: to read a book (32%), to read a newspaper (32%) and to have a quiet space (33%). Respondents would like to do some more leisure activities, like listen to music or radio (18%) or use the commuting time to have some extra sleep (17%). However, some respondents declared activities which might help them to switch their thoughts from home-based activities to work-based environment by for example doing useful work (19%), using laptop (12%), using Internet (19%) or listening to the news (17%). Although these may not be work-related activities, they may help with this transition from home to work. Overall amongst the groups, more ECs than NEC would be happy to do some useful work (e.g. 35% versus 12% for cost group) or use the Internet (e.g. 20% versus 17% for time group).

In addition, 14% of respondents specified watching TV as an activity they would like to do while commuting, but only for the effort group are the results statistically significantly different between EC and NEC at the 95% level and rise up to 24% for NEC and drop down to 11% for EC.

Activity	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Do useful work	19	17	21	12	35	18	20	18	21
Chi-square	-	0.42		16.98		0.03		0.34	
p-value	-	0.51		0.00*		0.85		0.56	
Use laptop	12	12	12	11	14	10	13	12	12
Use Internet	19	17	20	18	21	18	19	19	19
Read a newspaper	32	32	32	31	34	31	32	32	32
Listen to the news	17	19	15	16	18	24	15	18	16
Listen to music/radio	18	15	21	20	15	12	20	15	22
Watch TV	14	16	13	15	13	24	11	15	14
Chi-square	-	0.55		0.24		5.25		0.02	
p-value	-	0.46		0.62		0.02		0.89	
Read a book	32	31	34	34	28	22	35	33	32
Have a quiet space	33	35	32	35	30	41	31	33	34
Sleep	17	15	18	21	8	14	18	19	15
Chi-square	-	0.37		5.44		0.38		0.53	
p-value	-	0.54		0.02		0.56		0.46	
Other	5	6	5	6	4	4	6	6	5

Table 4.22. Answers to a question about activities commuters would like to do while travelling to work [%]. More than one answers option available. Highlighted items significant at the 95% significance level. Pearson Chi-square test used.

4.6 Conclusions

The analyses presented in this chapter were related to the three hypothesis of the study and were based on responses commuters stated in the paper or online questionnaire. The classification of respondents used in the study, where perceived self-reported data and actual data for alternative transport modes were analysed, distinguished between travel time, monetary cost, effort and generalised cost of NECs and ECs within the total sample of 223 respondents.

The first hypothesis (H1) of the study is unambiguously accepted on the grounds that it was possible to distinguish between EC and NEC when the 'pure' time, cost or effort method or the generalised cost method was employed. Therefore it is concluded that excess commuters can be identified in their commuting behaviour when the key travel parameters of journey time, monetary cost, physical effort are considered both separately as well as when they appear in combination with other parameters such as value of travel time or time penalty associated with walking in the generalised cost formula.

However, the detailed analysis of socio-economic, lifestyle and travel attitudes conducted for the four groups and compared against NEC and EC results presented in

this chapter did not reveal consistently significant differences between responses given by NEC and EC. The majority of analysis presented in the chapter show results which are not statistically significantly different at the 95% level between NEC and EC, what leads to conclusion that overall the two groups of excess commuters and non-excess commuters are not that different in terms of socio-economics, lifestyle and attitudes to travel. In most of the cases, where statistically significant differences between NEC and EC occurred, these were for the cost group, suggesting that classification of NEC/EC based on the cost parameter divides this sample into two slightly different groups in terms of travel behaviour and attitudes towards commuting. Overall however, the significant differences between NEC and EC occurred not for all, but for a limited number of choices within answers given to questions and thus do not offer a clear picture of EC's characteristics. Although some differences between NEC and EC within the four groups were identified, they are not enough to allow unambiguous acceptance of the second and third hypotheses.

The findings presented in this chapter confirm the difficulties in excess commuting calculations experienced by other authors who focused on one travel parameter of time or distance only (see Chapter 2). Moreover, the results present some challenges for interpretation, as the importance of contextual issues (social, physical and psychological factors) in the excess commuting classification, although analysed, provide a mixed picture as many of the differences between NEC and EC are not statistically significant. A deeper consideration of the hypotheses of this study will be investigated in the next chapter.

Chapter 5. Discussion and Evaluation

5.1 Introduction

The aim of this research, as identified in Chapter 1, is to explore the characteristics of excess travel within commuting. This chapter links the previous chapters of the literature review, methodology and analysis together and evaluates the study in the context of the six research objectives identified in Chapter 1.

Results of the literature review, Chapter 2, are evaluated in Section 5.2. A design of a complex methodology for the study, as described in Chapter 3, also in relation to the first hypothesis of the study, is evaluated in detail in Section 5.3. Section 5.4 evaluates the extent to which the second and the third hypothesis of the study, as identified in Chapter 3, have been met. Section 5.5 discusses results of the analysis, as presented in Chapter 4, in a broader context of the excess commuting literature and advice to public transport operators. The final section, Section 5.6, closes the chapter with conclusions.

5.2 Evaluation of the literature review on excess commuting and research gaps

The literature review chapter, Chapter 2, addressed the first objective of the study, which was:

> Objective 1: *to conduct a literature review focused on excess commuting phenomenon and identify research gaps.*
>
> *Chapter 1, Section 1.3, p. 5*

The purpose of this objective was to conduct a literature review on excess commuting, but also to take into account its relationship with the travel behaviour literature which is rich in its examination of the social and other frameworks such as positive utility of travel. This section reviews the contribution of the literature to the framework of this study.

Firstly, the evolution of the travel behaviour literature (see Section 2.2), brought together different concepts when looking at commuting (and more generally for travel) from travel as a derived demand to the recognition of positive utility of travel. The review also highlighted the increasing importance of positive utility of travel (Section 2.2) in evaluating commuting behaviour of individuals. A number of psychological

factors identified in the literature, such as 'buffer' or 'variety seeking' (intentional factor), influencing excess commuting have been listed. This shows that although excess travel behaviour occurs it is not necessarily 'wasted' commuting as commuters experience some psychological benefits during this journey, even when it is classified as excessive journey in terms of for example travel time or travel distance. The results of this study confirm that some individuals do value commuting time as an extra time for themselves (see Table 4.9), but the differences between EC and NEC are not statistically significant and did not allow a link between psychological factors and propensity of excess commuting behaviour to be derived.

Secondly, the critical review pointed to the role that urban structure plays, as explored by Hamilton (1982) and White (1988). This suggests that the degree of excess commuting may not be transferable between cities. In this study, due to problems with the origin-based data collection, the issue of urban structure and its relation to excess commuting phenomenon was not explored. Moreover, with the data collection being undertaken in a single city, it remains for further exploration the degree to which urban structure itself is influential, compared to alternative transport options.

Thirdly, the review of the literature presented a number of excess commuting definitions used by various authors (e.g. King and Mast (1987), Rodriguez (2004), Ma and Banister (2006)) and highlighted the way these focused on travel time and/or distance. Typically, the excess commuting definitions used the difference between the 'optimal' commute and average actual commute expressed in time and/or distance units with differences in monetary cost and effort required to conduct the travel being ignored. Time expressed in minutes, distance expressed in kilometres and cost expressed in pounds stirling are relatively straightforward to calculate, but little was found in the excess commuting literature to guide the question of how to introduce effort and this was met by using, in particular, the work of Stradling (2002), who distinguished and described three types of effort when undertaking journeys: physical, cognitive and affective (Section 3.4.1.3). This study and results presented in Sections 4.2.1-4.2.3 showed that it is possible to use single parameters of time, cost and effort to identify EC, although the effort element presented most methodological challenges due to the fact that effort has not been considered widely in the excess commuting context before.

Another problem with excess commuting definitions was that the authors were not taking into account other parameters which might influence excess travel behaviour, with perhaps the exception of Rodriguez (2004) and Handy *et al.* (2005), both introducing new points of view when assessing excess travellers ("voluntary" and "involuntary" versus "intentional" and "unintentional" excess commuting, respectively). A number of unintentional factors identified by Handy *et al.* (2005), such as 'habit' or 'misperception', is a reminder that excess commuting cannot be automatically classified as a voluntary or involuntary behaviour and needs to be carefully researched before clear conclusions regarding a surveyed sample can be made. This study has not found any evidence which would allow classifying respondents as intentional or unintentional excess commuters, although the EC classification methods, where respondents were asked to describe their attitudes toward commuting, showed some factors beyond time, cost and effort were potentially important (e.g. 'escape' from family obligations; see Tables 4.8 and 4.9).

Fourthly, the literature review enabled a framework of contextual, methodological and policy-related issues present in excess commuting studies to be created. The critical review discovered literature on excess commuting covering many countries and including or excluding different elements (e.g. gender, multi-worker household). The review enabled this study to bring together ideas into a structured framework that covers all important aspects of the literature. Thus this study builds on the existing framework to provide a holistic and comprehensive study. The literature was helpful in identifying many factors (e.g. social, physical and psychological factors within the contextual issue) that could be explored to assess their importance in the assessment of excess commuting. The review of this study concluded that methodologies used in previous research did not allow policy makers to draw clear conclusions from excess commuting research because of the variety of calculation methods and parameters used and uncertainty in terms of their importance in the excess commuting identification process. This led to very limited, if any, use of the research findings by policy-makers. By using a comprehensive framework, this study has laid the foundation for a more thorough treatment of the phenomenon of excess commuting and, in particular was structured so as to draw out advice for public transport operators and policy makers (see Section 5.5.1 below).

The literature review showed that in recent years more attention has been paid to psychological factors in relation to excess commuting (travel) and how these can influence EC classification (Section 2.4.2.3). The results of this study suggest that a very wide definition should be used in the research in order to ensure that an important element is not omitted. Even if urban structure means that the results are not transferable in terms of the percentage of excess commuters, this study was centered on people being the common factor with the core of the study being to understand what drives an individual to be an excess commuter.

5.3 Evaluation of the sampling and excess commuter identification methods

The methodology chapter, Chapter 3, addressed the second objective of the study, which was:

> Objective 2: to *design, develop and implement travel behaviour survey in appropriate case study areas in order to collect individual data on travel choices and identify potential for excess commuting behaviour.*
>
> *Chapter 1, Section 1.3, p. 5*

This objective addressed the first three gaps of the research (Section 2.6), which highlighted the need for a new case study on excess commuting as well as highlighting the importance of an individual approach in data collection and the importance of transport modes used in excess commuters identification. This second objective is therefore related to a design of an appropriate methodology, allowing for the identification of case study areas suitable for excess commuting behaviour investigation and these are evaluated in the three following sections. Section 5.3.1 evaluates two different sampling methods designed for targeting commuters at origin (home) or at destination (work) points. Section 5.3.2 evaluates the sample size and its implications on the final results. Section 5.3.3 focuses on the evaluation of first hypothesis of the study where two methods for excess commuters identification: the 'pure' method and the generalised cost approach were employed.

5.3.1 Evaluation of the sampling methods

As pointed out by the literature any case study will come with a fixed urban form which may have an impact on the results (see Sections 2.4.1.1 and 2.4.1.3). Tyne and Wear was used as it is typical of a middle size region in the UK, with areas both new and old

and where public transport usage is high overall (see Section 3.5.1) but with alternative travel options.

Two different approaches to sample selection were piloted and the GIS methodology was chosen for the main study because it had more advantages than disadvantages. This method proved to be appropriate for identifying hotspots meeting specified in advance travel-to-work criteria (see Section 3.5.3.1). In total, six different LSOAs, with good public transport service and working population over 50%, were used in the study (one LSOA in the pilot and five LSOAs in the main study). The pilot study achieved a 22.5% response rate. Although the main study response rate was much lower this was due to external problems explained in detail in Section 3.7.1.

In evaluating this approach to sample selection this study shows two main benefits of building a GIS for sample selection. Firstly, the GIS with 2001 census data gives good socio-economic characteristics of the selected sample (e.g. areas with high number of commuters using public transport) which then allows the comparison of these characteristics with collected results (e.g. actual number of public transport users in the sample). Secondly, GIS makes the specification of a geographical location of the sample easy which then helps to identify transport alternative options between origin (targeted with the questionnaire) and self-reported by respondent destination point. It also has the added advantage of improving data capture since identification of location is still possible for respondents who fail to report their home postcode. The disadvantage of this approach to sampling is that it is time-consuming to build a GIS system and requires GIS-skills for implementation. However, the benefits of providing customised sample hotspot identification with an analytical justification outweigh the time disadvantage. As a tool in sample selection, this method could be improved upon by the use of more recent population data although this is an issue faced by all researchers as the existing census data becomes dated. In addition, the visual assessment of public transport links (e.g. bus stops, distance to metro stations) within LSOAs used in the selection process could be replaced with a more sophisticated GIS analysis such as network analysis.

Through force of circumstance the destination method was used in the main survey although it was the second best choice. This method was used for two large employers in Tyne and Wear, as described in detail in Section 3.6.1 and 3.7.2. The benefits of

using destination-based sample in the study were related to time and cost savings in the overall data collection process. However, this approach was limited by an absence of additional socio-economic groups (workers at different levels within the public sector as well as other sectors). In addition, as the total number of employees within each organisations was not known, it was impossible to establish a response rate and maybe more susceptible to bias by targeting a specific group of employees (e.g. with work e-mail address only). A destination-based sample also requires more good-will in the sense that both employer and employee need to be willing to participate. Of the five local authorities in Tyne and Wear, only one was willing to give the online link to the survey to their employees which was very disappointing and affected the final number of respondents as well as a limited geographical coverage of the survey within Tyne and Wear. This could be improved by engaging with local authorities and public transport operators at an earlier stage of the study via for example their patronage or joint dissemination activities.

The evaluation of the two sampling methods used shows that both were appropriate for the data collection in the study, although the origin-based approach was preferred due to its ability to compare the results with census data. Both methods were successful, to some extent, in collecting responses, however the final sample size was much smaller than originally sought and this had implications for the statistical analysis undertaken in terms of making it more difficult to identify significant differences between EC and NEC respondents. Overall, if a larger and more detailed (in terms of socio-economic characteristics) sample was available it would probably allow for more sophisticated statistical analysis to be achieved beyond the results presented in Chapter 4. As a consequence this would help in terms of comparing the sample against census and transport (travel) data for the region and improving further understanding of excess commuting and its importance for the local transport policy.

5.3.2 Evaluation of the sample size

A much larger sample was intended than was eventually achieved in the study. The fact that the study continued both origin and destination-based approaches for data collection in the main study had a number of implications with both origin and destination-based approaches in the main study had a number of implications for data collection.

Firstly, it is difficult to evaluate similarities between the main and the pilot studies because the proportion of origin and destination based samples are different (response rate was 16.0% for the pilot and 4.9% for the main study). Table 5.1 presents final numbers of questionnaires received in the pilot and the main study. Therefore the pilot study can only be treated as a guideline for the main data collection stage, but no statistical analysis could be undertaken on the pilot data to compare the characteristics of the respondents from the pilot and the main studies.

Sample		**Pilot study**			**Main study**		
		Delivered	**Returned**	**Used**	**Delivered**	**Returned**	**Used**
Origin-Based	[count]	280	63	**45**	1,640	166	**81**
	[%]	100	22.5	16.0	100	10.1	4.9
Destination-based	[count]	N/A (online + paper)	42	**40**	N/A (online)	157	**147**
Total number of responses [count]		-	-	**85**	-		**233**

Table 5.1. Final sample size for the pilot and the main study.

Secondly, the dominance of the destination-based respondents in the main study (the origin-destination-based respondents' ratio approx. 1:1 in the pilot and approx. 1:2 in the main study) makes it more difficult to generalise to the population as a whole because this group cannot be related to the census information, as originally planned. This means that the analysis related to EC and NEC in the sample cannot be extended to the population of Tyne and Wear as was intended.

The total sample size, collected from origin and destination-based samples, for the main study was 223 respondents, where females formed 60% of the group. A possible explanation for the majority of respondents being females is that, in general, females are more likely than males to answer travel questionnaires (Buchanan, 2010a; Buchanan, 2010b). This gender bias also means that the collected data should be interpreted with caution, especially when making gender comparisons for travel behaviour. Although this 6:4 gender ratio was recognised in the analysis (see Table O.1 in Appendix O), the focus of analysis presented in Chapter 4 was on other than gender characteristics and the only statistically significant socio-economic difference in results between NEC and EC occurred for marital status (see Table 4.7).

5.3.3 Evaluation of the two methods of excess commuters identification

This study used a questionnaire technique to collect information about travel behaviour within commuting. The data was cleaned and analysed in SPSS^{TM}. The first hypothesis, as presented in Section 3.2, assumed that excess commuters exist and was formed as follows:

> H1: *Excess commuters can be identified in their commuting behaviour.*
>
> *Chapter 3, Section 3.2, p. 43*

The literature review showed many different ways of identifying excess commuters (see Sections 2.3 and 2.4). Within the methodological framework this study investigated two different methods of increasing complexity, namely 'pure' and generalised cost method. The intention was to see whether the results pointed to a methodology for identification of excess commuters that was optimal.

The analysis showed that the easiest way of ensuring comparative results is to use the 'pure' method. In fact, detailed calculations for the main sample identified different numbers of time EC, cost EC and effort EC (see for example Table 4.10). The evidence also shows that there are more excess commuters when a single parameter is taken into account (e.g. time, cost or effort) than when results for various parameters are combined when the number of excess commuters decreases (see Table 4.6). This agrees with earlier observations (see Table 2.1), which showed that EC identification depends heavily on the methodology used. Within the 'pure' methods, the simplest parameter to measure is time and it is very easy to compare individuals by comparing their self-reported travel time with times for alternative options (based on for example timetable). However this 'pure' approach neglects the complexity of the issue.

This simplest 'pure' method produced the most excess commuters even though a more comprehensive approach is more credible in the light of the literature review which shows different factors have been taken into account in the process of identifying excess commuters. In particular, finding a way to include time, cost and effort into travel behaviour decisions has implications for transport policy evaluation in changing the value of travel time savings. This approach also provides a challenge and an evidence base to question the theory treating individuals as cost minimisers and subsequent valuations of travel time savings.

This study recognises the generalised cost method offers a more complex approach to excess commuters identification. The method distinguishes between car and public transport users and the results (see Section 4.2.4) show that this approach identifies more EC for the car alternative than for public transport alternatives. This might be because of the complexity of variables used in equations (see Section 3.4.2) which are different for car and public transport, or because of the use of out-of-date values of parameters used (e.g. VOT, VOC values based on data from 2001) which need to be revised and updated.

Overall the 'pure' and generalised cost methods and testing of various saving options (see for example Table 4.2) allowed for measuring the existence of excess commuters quantitatively (see Section 4.2). It was found that if one is looking for reliability across cities and countries using time only is likely to give one the most consistency. However, this approach misses out many important factors (e.g. urban form, cost of travel, psychological parameters, VOT) that a robust method, that includes financial cost and some form of effort, is better linked to the travel behaviour literature and would be the preferred method. The generalised cost formula, which includes time, cost, VOT and other elements, needs to be improved and somehow take into account cognitive and affective effort, because both can improve our understanding of commuting journeys in relation to for example advanced planning or stress related to the journey itself. More tests on weights for walking, waiting and interchanges in addition to overall effort are needed in order to improve the way excess commuters are identified. Further exploration is needed to understand the interactions of the different elements for individual commuters, with a larger dataset and this is part of the recommendations for further study.

5.4 Evaluation of the excess commuting examination within the sample collected

The analysis of results chapter (Chapter 4) addressed the third objective of the study, which was:

> Objective 3: *To examine the excess commuting phenomenon within the sample collected to understand the drivers of excess commuting.*
>
> *Chapter 1, Section 1.3, p. 5*

This objective is focused around using various techniques suggested in the literature in order to select most suitable and reliable methods for understanding of excess

commuters. It tests whether it is possible to provide a framework in which knowing something about a population will also tell something about excess commuting.

This was examined through two hypothesis of the study based on analysing differences, if any, in the characteristics of EC and NEC within the sample collected. This section evaluates the two hypotheses governing characteristics of excess commuters, where H2 is related mainly to socio-economic characteristics and H3 is related to other factors influencing travel choices.

5.4.1 Evaluation of the second Hypothesis

The second hypothesis (H2) of the study, as presented in Section 3.2, was:

> H2: *Travellers exhibiting excess travel in their commuting behaviour can be understood through socio-economic, lifestyle and travel attitudes.*
>
> *Chapter 3, Section 3.2, p. 44*

The literature on excess commuting gave little attention to socio-economic characteristics, with the exceptions of Kim (1995) and Buliung and Kanaroglou (2002), who showed that factors like for example multi-worker households or tenancy status can have a role to play in excess commuting assessment. This lack of attention to socio-economic factors conflicts with travel behaviour research where socio-economic characteristics have been found to be important (e.g. Russell *et al.,* 2011).

In testing the second hypothesis, various statistical methods were employed. The analysis presented in Section 4.3.1 suggests that a weak link may exist between EC and their marital status within the cost group where 62% of EC are classified as married (versus 49% of NEC) and 17% of NEC are separated (versus 3% of EC). Analysis of attitudinal statements regarding commuting did not reveal any statistically significant differences between NEC and EC for variables determining commuting such as “good access”, “good safety” or “short distance” (see Table 4.8 for details). However, within the total sample these three variables scored highest (median = 5 on a 5-point scale) out of the eleven variables mentioned with “curiosity of new places” scoring lowest (median = 2). This result shows clearly that the parameters of transport options such as accessibility, safety and distance play an important role in selecting commuting transport modes and “curiosity” factor plays a secondary role. However, there was no evidence found which would allow classifying excess commuters within the sample as

voluntary and involuntary (after Rodriguez, 2004) or intentional and unintentional (after Handy *et al.*, 2005).

Further analysis of 23 attitudinal statements related to travel to work characteristics (see Table 4.9) showed that results for eleven statements are statistically significantly different between NEC and EC, with six of them significant for the cost group. This shows that the cost classification method is distinctive from the other three methods of time, effort and generalised cost, as the way it splits EC and NEC allows for identification of significant differences between the two groups. This could be explained by the 'pure' method of EC identification, which weights the contribution of money most highly and this is clearly reflected by the relevance of attitudes (see Tables 4.8 and 4.9). Whilst the generalised cost approach also includes the monetary cost of commuting this is diluted by elements of time, effort and other parameters which might be the reason for attitudes being less important.

Although other observed differences between EC and NEC, relating to H2 were not significant, some important differences between EC and NEC occurred (e.g. across all the four groups more EC than NEC are driving to work). The evaluation suggests that for the generalised cost approach, where the split of NEC to EC was 123:100, very few significant differences were found. As the generalised cost method is more complex than the 'pure' approach, it seems that single parameter classification allows for more significant differences between NEC and EC in the study to be identified. But, as evaluated in H1, the generalised cost approach needs to be improved in order to represent other important factors such as urban form or psychological parameters (Section 5.3.3).

The investigation of H2 has showed some weak support for the relevance for socio-economic characteristics (see Section 4.2). Whilst weak support is shown it is unclear whether further investigation requires a bigger sample to see whether the lack of significance is due to the sample size or really to the fact that socio-economic factors are not important in better understanding of excess commuters. Therefore H2 is accepted in a limited way for the cost group only, where the differences between NEC and EC are most visible in the results presented. Overall, H2 is neither accepted or rejected comprehensively and provides the basis for the further work discussed in the next chapter (Chapter 6).

5.4.2 Evaluation of the third Hypothesis

In Section 3.2 it was hypothesised (H3) that:

> H3: *There is a relationship between the different factors influencing travel choices and the propensity for excess commuting.*
>
> *Chapter 3, Section 3.2, p. 45*

The analysis of different factors presented in Chapter 4 show very few significant results for differences between NEC and EC. In some ways H3 is looking at the factors (e.g. alternative modes available, sources of information about alternatives), which are outside of individuals control to see the impact on the individuals propensity for excess commuting.

Only three out of ten suggested reasons for not using alternative transport modes ("more time consuming", "parking problems" and "need of flexibility") were significantly different between NEC and EC across selected groups and showed that only the effort EC were much more concerned about longer travel time than NEC. All the other comparisons, related to: physical, cognitive and affective effort; and time and cost spend on commuting, did not provide evidence for statistically significant differences between EC and NEC. However, this evidence is strong support for widening the definition of excess commuting as effort appears to play some role.

Within the generalised cost group only one result related to H3 analysis was found to be statistically significantly different between NEC and EC, and related to the stress of commuting; "being late". However, the results for this factor were also identified as statistically significantly different between NEC and EC within the time and the cost groups, so this result for the generalised cost group could not be recognised as unique but again shows the need to widen the analysis beyond 'pure' EC identification.

As the analyses presented in Section 4.4 provided very little evidence for statistically significant differences between NEC and EC within the four groups and for a relationship between the different factors influencing travel choices and propensity for excess commuting H3 is therefore rejected overall. The fact that no significant differences between NEC and EC were found within the four groups, even when the most complex generalised cost approach was used, shows that in this study the factors influencing travel choices do not relate to the EC. Overall, H3 is rejected and further

research would need to use a larger sample to allow an investigation of causality that builds on the investigation in this study.

5.4.3 Overall findings

The findings presented in Chapter 4 confirm the difficulties in excess commuting calculations experienced by other authors who focused on one travel parameter of time or distance only (see Chapter 2). Although the literature review highlighted the importance of contextual issues (social, physical and psychological factors) in excess commuting classification, this study showed that in the majority of the cases where contextual issues were analysed no statistically significant differences in socio-economic variables were found. Moreover, the analysis of attitudes showed that the cost-driven split between NEC and EC is different from the other three groups, as the majority of statistically significant differences between NEC and EC occurred within this cost group. It was concluded that financial costs of commuting are far more important to respondents than other measures such as travel time or effort and this supposition should be tested in further study.

Overall, the third objective of the study, which was examined through two hypothesis of the study, was fulfilled. However, both hypothesis, which investigated socio-economic and attitudes of commuters and relationship between different factors influencing excess commuting, were not accepted comprehensively with results not being able to identify clearly and comprehensive differences between NEC and EC within the groups. However, as shown in the literature review, many studies on excess commuting have struggled with the complexity of the problem and this study is no different. Nevertheless, by providing a framework in which different measurement methodologies have compared EC and NEC this study provides a better understanding of that complexity.

5.5 Evaluation of the results in the context of current literature and advice to public transport operators

This chapter, Chapter 5, addresses the fourth objective of the study, which was:

> Objective 4: *To discuss the results obtained in the context of the contribution to the existing literature and transport policy, particularly what this study has shown for public transport operators.*
>
> *Chapter 1, Section 1.3, p. 5*

A strong relationship between excess commuting and land use has been reported in the literature (see Section 2.4.1.3). Prior studies that have noted the importance of methodological issues in excess commuting focused their efforts on investigating geographical boundaries, different measures and spatial structure (see Section 2.4.1). Less attention has been paid to the contextual issues influencing excess commuting, which included social, physical and psychological factors. Although policy issues in the context of transport and land use policies were mentioned by a number of authors investigating excess commuting (e.g. Yang (2008); Murphy (2009)), they were given a marginal importance. This was caused by the use of a wide variety of complex methods used to study excess commuting that did not easily allow clear conclusions and policy actions to be presented.

This study sought to examine psychological issues within excess commuting by analysing respondents' attitudes towards commuting and the importance of factors such as "safety" and "enjoyment" in selecting travel-to-work transport options. The results presented in Section 4.3.2, however, show that the differences between NEC and EC are not statistically significant in the majority of the cases indicating that although some factors might be more important than others in making travel decisions (e.g. overall "good safety" more important than "good comfort" or "good enjoyment" more important than "curiosity of new paces"; see Table 4.8 for details), they do not necessarily distinguish EC from NEC in the sample. Perhaps more detailed questions related to commuting preferences and opinions in the questionnaire supported with in-depth interviews with respondents would allow for a better assessment of the importance of psychological factors in excess commuting.

5.5.1 Advice for public transport operators

Embedded in the travel behaviour domain, this study has identified issues raised by survey respondents which could be turned into advice to public transport operators (PTO) as to how their services can be improved in order to better meet commuters' needs. Moving to more sustainable commuting patterns is a joint responsibility of both operator and user with the PTO's role being to communicate with current and potential customers to provide the incentive for behavioural change. This would allow the potential benefits to individuals (local environment or physical health) and to society (reduction in emissions) to be realised. Therefore, this study provides the opportunity to present evidence to transport planners on opinions made about commuting and in

particular the way in which commute choices are not only about time/cost trade-offs, but include other facilities that might be available on public transport services.

Detailed advice for public transport operators, based on the emerging points highlighted by the results of the study are:

1. Firstly, a safer environment inside public transport vehicles allowing passengers to peacefully "switch on" for work was identified as an important change that is required (see Table 4.22). This result confirms the findings of Ory and Mokhtarian (2004), who found that the perception of travel as an "escape" time offers some commuters the only time during the day when they have time for themselves. Moreover, commuters would like to use their travel time productively by reading newspapers or books but also by "switching on" a working mode by doing some useful work. To do this they need privacy and some quiet space where they can concentrate and mentally prepare for work by 'resetting' their minds and thoughts. Public transport could offer users opportunities to read magazines and literature (similar to a widespread practice of free Metro newspaper distribution on public transport) but also in terms of monitoring people's inappropriate behaviour in terms of loud music, mobile phone use etc.

2. Secondly, "regular and reliable" services, "more direct routes" and "friendly staff" are as important as "cheaper fares" (see Table 4.21). The first two issues have been highlighted by over half of the sample (57% and 53%, respectively) as factors which could encourage them to use public transport more often. Commuters do not bother so much about investment in technical improvements, such as upgraded vehicles or smart cards (such as the "oyster" card) but investment in dealing with customers' training is recommended with "friendly staff" being appreciated by nearly 15% of the sample. This is in line with findings provided by Ipsos MORI (2010) on expectations from public services where "staff professionalism" (16%) and "attitude" (12%) were identified as important drivers for the overall customer satisfaction with public service. This shows that beneficial changes lie in the field of people's perception of the public transport and cost of travel, although technological improvements are important to some.

3. Thirdly, there is potential to convince half of the sample to use public transport alternatives instead of their current transport arrangements (Table 4.14) if the alternatives were a minimum of £1 cheaper and a minimum of 10 minutes quicker than respondents' current travel options. But to achieve this, some improvements in infrastructure (e.g. more bus lines) and service reliability (e.g. better punctuality) is needed. Also effective marketing tools, such as for example Tyne and Wear Metro service status updates at www.nexus.org.uk, would need to be used more widely by PTO to maintain their contact with clients as well as to communicate the message about the advantages of public transport to the public. The Internet, as well as workplace, was the most frequently used place to find information about transport options for respondents. Therefore the Internet, as well as close cooperation with employers, should be used widely as tools for communicating the message about public transport services to a wider audience. This last finding supports the Smarter Choices agenda for Tyne and Wear Local Transport Plan 3, published in 2011, where the focus is on individualised e-marketing and "wider-scale and more intensive targeting of employers with general Smarter Choices measures and incentives, using innovative practice where possible" (TWLTP, 2011, p. 132). As confirmed by other research "better information and discounted tickets are often key to promoting the use of public transport" (Newcastle University, 2009a, p. 39).

The above suggestions show that beneficial changes appear to lie more in the field of people's perception of public transport rather than high-tech buses or smart tickets. All three recommendations are possible to achieve with some additional (financial) resources, creativity and willingness for change from public transport providers.

5.6 Conclusions

This chapter presented discussion and evaluation of the objectives of the study. The first objective has been met by conducting a literature review on excess commuting which revealed the complexity of the phenomenon. The critical review highlighted the structural framework of contextual, methodological and policy-related issues and led to the identification of the four research gaps. The gaps have been met by focusing the research on a Tyne and Wear case study, where an individual approach in the data

collection process as well as clear distinction between travel to work made by a car and by public transport modes led to the employment of two broad approaches for excess commuters identification. The 'pure' method with parameters of travel time, financial cost and travel effort employed in separate classifications proved to be a simple and effective approach for distinguishing between EC and NEC within the sample. This second method of generalised cost was more complex as it not only included time, cost and weights representing effort, but also other parameters of travel. Both methods identified EC within the sample, meeting the first hypothesis of the study. Although the 'pure' method can be criticised for simplifying the excess commuting phenomenon, it actually revealed some statistically significant differences within the groups between NEC and EC. However, those differences did not allow for accepting the second hypothesis of the study, which was hoping to contribute to better understanding of the phenomenon by analysing socio-economic, lifestyle and attitudes of EC and NEC. Moreover, the analysis that related to the third hypothesis of the study, investigated relationships between various factors influencing travel choices and propensity for excess commuting. However, no evident for such a relationship was found.

Overall, the study confirmed excess commuting issue is an extremely complex phenomenon. Nevertheless, the study has contributed to the understanding of the disentanglement of the contextual, methodological and policy-related issues that can only been seen within the more holistic methodology used. Although the lack of significance in the factors investigated between EC and NEC, this study has highlighted where further work might profitably provide more evidence.

Chapter 6. Conclusions and Recommendations

6.1 Introduction

The aim of this chapter is to draw conclusions from the study based on the material presented in the previous five chapters and recommend directions for future work. This chapter finalises the thesis by first identifying the major conclusions (Section 6.2) and secondly by highlighting contribution to knowledge (Section 6.3). Next, the chapter considers limitations of the study (Section 6.4) and proposes how this study could be extended in the future to create further understanding in the area of excess commuting (Section 6.5). The final section, Section 6.6 brings conclusions to the chapter and to the study.

6.2 Conclusions from the study

The primary aim of this research was to explore the characteristics of excess travel for the commute in order to better understand the nature of the phenomenon. In order to meet this aim, five research objectives were introduced in Chapter 1 and tested throughout the study with results reported in Chapters 2-5. The framework for research included the development of a methodology for the identification of EC within a sample drawn from a population using GIS techniques and to investigate, using a questionnaire approach, whether the preferences and attitudes of commuters differentiated depending upon if they were EC or NEC.

The first objective of the study was related to conducting a review on existing excess commuting literature in order to identify research gaps. The critical review presented in Chapter 2 built on review presented by Ma and Banister (2006) and highlighted three types of contextual (e.g. multi-worker households), methodological (e.g. spatial structure) and policy-related (e.g. work-house balance) issues present in the literature. In addition, the critical review emphasised an importance of the positive utility of travel and psychological factors such as 'buffer' or 'variety seeking' in travel behaviour studies, which had been ignored in excess commuting studies. Overall, the findings of this study enhance our understanding of commuters' behaviour within the context of the travel behaviour literature generally and more specifically, within the growing body of literature on excess commuting. We learn for example that factors such as geographical boundaries or tenancy status can play a role in quantifying and understanding excess commuting.

The second objective of the study was related to designing, developing and implementing travel behaviour survey using a new case study. The literature review suggested that it is important to collect data on travel choices at an individual level rather than from aggregate data to identify the potential for excess commuting. The first part of the objective was met by designing and testing two approaches to sampling with the first focused on origin-based (home) sample and the second on destination-based (work) sample. The first approach revealed an important role for GIS in establishing a sample for travel behaviour study, however the second approach was able to provide a larger dataset for the study.

The second part of the objective was met by testing H1 of the study which hypothesised that excess commuters can be identified in their commuting behaviour. The study introduced a new a new approach for calculating excess commuting where self-reported values of single parameters such as travel time, monetary cost or effort were compared with transport alternative options for various excess thresholds as well as more comprehensive generalised cost approach. The results revealed that it is possible to identify EC using both the 'pure' and the generalised cost methods, however the second method is more complex as it used various parameters in addition to the three parameters tested separately in the 'pure' method. Whilst this latter methodology also revealed fewer EC, the conclusion is that a generalised cost approach sits better in the travel behaviour literature and is therefore to be preferred.

The third objective of the study was related to examining the excess commuting within the collected sample in order to understand the reasons of excess commuting behaviour. This objective was met by testing two hypotheses of the study where the first (H2) hypothesised that excess commuters can be understood through analysing their socio-economic characteristics and travel attitudes; and the second (H3) hypothesised that there is a relationship between various factors influencing travel behaviour and propensity for excess commuting. Results related to the two hypotheses, presented in detail in Chapter 4, showed that in the majority of cases the differences between EC and NEC were not statistically significant. This meant that, according to the EC classification used in the study, EC and NEC were similar in terms of socio-economic characteristics and travel attitudes. Although some significant differences between EC and NEC occurred, these did not allow for saying with confidence that the two groups were different but were sufficient to suggest that only taking time or distance into

account is not enough. The only exception was for the cost group of EC and NEC where the majority of results were significantly different. This revealed that cost has an important role to play in excess commuters identification and other factors are somehow less important. However, the majority of results presented within the context of the third hypothesis did not allow for identifying any relationship between factors such as for example knowledge about transport alternatives or ideal-one way commute time and the propensity for observing excess commuting behaviour.

The fourth objective of the study was related to the results presented in the study and their context and contribution to the existing excess commuting literature and transport policy. This study showed the high importance of methodological and contextual issues and how they can affect the final results obtained. The advice for public transport operators, presented in Chapter 5, with recommendations related to safe and comfortable environment, regular and reliable service, friendly staff, cooperation between PTO and employers, e-marketing showed the public transport sector a direction for future improvements.

The fifth objective of the study, which is related to the contribution of this study to the current knowledge of excess commuting literature, is presented in Section 6.3.

6.3 Contribution to knowledge

The fifth objective of the study was:

> Objective 5: *to investigate the implications for the findings of the research in terms of contribution to the current knowledge of excess commuting phenomenon*.
>
> *Chapter 1, Section 1.3, p. 5*

This study has identified huge challenges in defining the excess commuting phenomenon and in establishing methodological and statistical approaches to successfully characterise excess commuters. However, the study was effective in providing insights how to address these challenges.

Firstly, the literature provides various definitions of excess commuting and this study was able to highlight different perspectives when looking at the phenomenon. The

critical review showed that although excess commuting as a topic has attracted the attention of transport researchers, previous studies have been mainly focused on the two parameters of travel time and travel distance with a limited exploration of other variables. In asking how confident a method can be in identifying and quantifying EC, the answer is that it depends on how excess commuting is understood overall and what parameters are taken into account in the final assessment of identifying excess commuting.

Secondly, this study adapted a simple methodological approach in order to verify how many excess commuters are in the sample collected. The analyses showed that the results depend strongly on the criteria used to identify excess commuting. This study used a new approach for calculating excess commuting where self-reported values of single parameters such as travel time, monetary cost or effort are compared with transport alternative options for various excess thresholds as well as more comprehensive generalised cost approach were successfully implemented. The study established that if time is the main driver then it is relatively easy to distinguish between EC and NEC based on actual commuting time performed by individuals and alternative options available. However, the more parameters of travel that are added to the criteria of identification, the more complicated the issue becomes in terms of calculations and reliability of values of parameters used (e.g. DfT recommends values for VOT based on data from 2002). In addition, there is the psychological dimension of excess commuting, drawn from the travel behaviour literature, which should not be neglected at the analysis stage. Although psychological factors were not included in the excess commuting identification, a new simple method for identifying three aspects of commuting effort (physical, cognitive and affective) was introduced, tested and implemented in the analysis. While analysis revealed no statistically significant differences were found between NEC and EC in relation to effort, it has been shown that the effort parameter can be used for distinguishing NEC and EC in the sample.

Thirdly, this study enriched the portfolio of excess commuting studies with a new UK-based case study. Although Tyne and Wear was originally planned to act as a representative region, where results gathered could be generalised for the population as a whole, this was not possible due to complications at the data collection stage. However, the collected sample of 223 commuters from Tyne and Wear is still useful in better understanding of local transport challenges related to transport choices and

highlights issues (e.g. parking prices, workplace travel plans) which are important locally.

Fourthly, the attractiveness of the GIS approach in travel behaviour study has been shown in this research. The results revealed that an origin-based sampling method, where topographic map data, census data and data on local transport provision are employed, is a good tool for identifying 'hotspots' for a travel behaviour study. This tool allows potential respondents to meet a certain criteria important for the study by selecting, for example, specific socio-economic characteristics. This issue was recognised as a contribution to knowledge and the outcomes of the GIS approach in a travel behaviour survey are now published (Fraszczyk and Mulley, 2014), following their presentation at the Royal Geographical Society Conference in 2012.

Finally, the study has been able to produce and validate results which contribute to a better understanding of excess commuting behaviour. The analysis showed that a single-parameter driven analysis allows for the identification of EC, but also highlighted that the issue of excess commuting is more complex and cannot be treated with simplicity. Although many of the differences between EC and NEC were not statistically significant the results did show differences between the EC and NEC when different parameters played a leading role in EC identification. Also, the results distinguished factors influencing commuting behaviour which are more important (e.g. good safety) from factors which are less important (e.g. good accessibility).

6.4 Limitations of the study

The evaluation of the objectives of this thesis has identified a number of limitations and these are considered alongside other limitations of the study in this section.

Firstly, the Tyne and Wear GIS, designed in 2006/2007, used socio-economic and travel-to-work data collected in 2001 during the 2001 census. At the time of designing the system the census data used was already five years old. By the time the pilot study took place in 2008, the data was seven years old. Moreover, when the main survey was distributed in the five LSOAs in Tyne and Wear, the census data was nine years with only one year left before the new 2011 census collection. Clearly, the socio-economics and travel-to-work data reported in 2001 were out-of-date when the main data collection took place although more recent census data was not available. If more up-to-date data

was available to select hotspots meeting the original requirements, it is possible that other LSOAs would be identified for the data collection.

Secondly, the current study was unable to find statistically significant results in the majority of its analysis of results for NEC and EC and this may in a large part be due to the sample size (n>300) and/or the methodology of the classification of EC and NEC. After overcoming a series of complications with data collection the final sample size included 223 respondents. The original idea was to use origin-based sample from Tyne and Wear, where selection was based on the 2001 census data only. A representative sample of the population would then have allowed generalisation of the results for the population of the Tyne and Wear. However, the final sample was composed of origin as well as destination-based samples with the respondents' ratio of 1:2. As mentioned above, less information was available for the destination-based population and this has an impact on the ability to generalize to the population. Moreover, most of the results presented in Chapter 4 were not statistically significantly different between NEC and EC. However, this does not negate the final results, but means caution must be exercised in generalising statements about the population from the sample.

Even if the sample had been representative for the Tyne and Wear population, the transferability of these to the population of the UK and elsewhere is a question that would require more investigation. It has been shown that issues related to the population of the UK should distinguish the unique characteristics of London as a capital city from city characteristics of the rest of the UK. So whilst this research is based on a case study, deliberately chosen to be outside the capital, it is not clear whether the sample composition would have allowed the results to be tentatively true for other areas of the UK. This is in line with the literature where it was highlighted that each study area is unique and the generalisation of results achieved requires care.

Thirdly, the questionnaire technique for this data collection could be improved. The pilot study helped to improve the original version of the questionnaire and implement changes before the final questionnaire was distributed. The intention of the questionnaire was to collect data about daily commuting behaviour, but more detailed questions regarding route between home and work could be asked with benefit to the analysis. Intentionally, the questionnaire did not include a Tyne and Wear road map for people to mark their origin-destination route as it was recognised that not all

respondents might be able to read maps and the method used home and work postcodes together with a description of transport modes to identify possible routes. However, it would be useful to have more detailed information on the routes taken which in turn would allow more accurate calculations for the routes and their alternatives to be suggested. A longer questionnaire could seek more detailed information relating to the monetary cost involved in travel to work (questions about cars and costs of insurance, petrol, maintenance, parking etc.) but it should be recognised that additional length may have an impact on completion rates.

Fourthly, the socio-economic variation of the investigated sample could be improved. Although the survey was designed to target a variety of employees within Tyne and Wear area, the majority of the main sample was formed by public sector workers (Newcastle City Council) who had work e-mail addresses due to sample collection issues. Greater variety in socio-economic groups of employees would allow for a comparison of travel behaviour at different levels of employment (e.g. from manual workers to management staff).

6.5 Recommendation for the future work

Although the objectives of the study have been met and this study is considered as complete, the research that has been undertaken means that the next steps in this area which merit for future development can be more easily identified. Prioritised areas for further research, which would enhance the results of this study, should be undertaken in the following areas:

1. Further investigation of the relationship between effort and people's perception of time, cost and distance is needed. More work needs to be done to establish whether more elements of effort (e.g. physical and cognitive and affective) can be implemented into a generalised cost or similar formula which can take account of multiple factors. This means further exploration is needed into how sensible it is to rely on cost minimisation to determine peoples travel behaviour. This also suggests that cost minimisation by itself is not sufficient to explain all travel behaviour (if it was we would not be able to identify any EC) and effort is clearly an important part of the travellers consideration in making their travel plans. This reinforces the point made by Ma and Banister (2006) that further multidisciplinary research linking psychologists and transport planners is

required to undertake excess commuting research in order to introduce a comprehensive definition of excess commuting in a robust and quantitative way.

2. To understand commuting better, a sample representing various socio-economic groups of the population is required to determine whether the differences between EC and NEC occur and if they are statistically significantly different between the groups. Therefore the future work should involve respondents who represent a wide spectrum of socio-economic backgrounds.
3. As indicated earlier, the number of excess commuters, where more than one parameter is taken into account at one time (e.g. time and cost EC or generalised cost EC), in any sample is expected to be small. This means there is a need for an enlarged sample – of the size planned for this research. With a larger sample, the analysis should be able to distinguish better between differences which are significant and differences which are not with some confidence.
4. Implementing change in public transport operation is an important area of future research. This requires stronger collaboration between researchers, PTO and transport policy makers to determine how to implement the findings from excess commuting research into practice. Such collaborations as, for example, the "Smartcard for Nexus" initiative between Nexus and Newcastle University (Newcastle University, 2014) could help PTO increase their market share by providing a service which is more attractive to commuters (in this case students from Newcastle University) and which in turn will assist commuters in their travel behaviour decisions and hopefully stimulating their positive utility of travel and changes in their travel-time use. Therefore future studies need to involve policy-makers and public transport operators at the both strategic and operational levels to ensure a wider implementation of the findings is achieved and that recommendations are implemented and adapted by the transport sector.
5. Travelling more sustainably has impacts for the environment and health (Hutton, 2013) and an extension to the analysis conducted in this thesis might be to link excess commuting identification using measures of CO_2 emissions, its carbon footprint or sustainability to identify EC as well as time, distance, cost or effort with the results being used influence sustainable travel choices promotion and initiatives such as for example Newcastle Sustainable Travel Guide (Newcastle City Council, 2014).
6. Finally, the issue of teleportation has only been briefly touched on through the questionnaire and analysis. Nevertheless, this study has identified that

commuters' perceptions on teleportation and the links with excess commuting are interesting. A further investigation would be required to test how teleportation (as an abstract issue; Mokhtarian and Salomon (2001)) and telecommuting (as a real alternative to travel; Vana *et al.* (2008)) influence willingness to minimise travel parameters in terms of time, cost and effort and how they might be linked to different sets of socio-economic characteristics or perceptions and attitudes towards commuting as well as propensity for excess commuting.

6.6 Conclusions

This chapter reviews objectives of the study, draws conclusions and provides directions for future work. The major conclusions are related to the five objectives of the study. The first objective was met by showing that there is a rich literature on excess commuting phenomenon which provides various definitions of EC and methods for their identification. Designing and implementing a successful data collection in Tyne and Wear, as a selected case study area, and identifying EC within the sample met the second objective. The third objective was met by analysing differences between EC and NEC within the groups and by showing the complexity of the issue. Recommending a number of improvements in the public transport sector, such as strong cooperation between PTO and employers and effective use of e-tools, met the fourth objective.

The final objective was met by identifying the way in which the study contributes to knowledge. This contribution was achieved by showing 'pure' and generalised cost approaches as tools for EC identification; by enriching the literature with a new UK-based case study; by proving that GIS can be used as a tool for selection of sample areas in a travel behaviour survey; and by highlighting how complex the issue of excess commuting is.

The chapter also lists a number of limitations of the study, with the major points being related to: the age of census data used in the GIS, small sample size and its limited socio-economic characteristics, the questionnaire itself, and the time for conducting the research.

Finally, based on the work achieved in this study, this chapter provides some directions for the future work, which are focused on: untangling of the relationship between

various parameters of travel and their importance in making travel choices leading to excess commuting; investigating various socio-economic groups of the population; collecting a larger sample; establishing research collaborations on excess commuting between PTO, policy-makers and researchers; investigating sustainability issues in the context of excess commuting; and analysing the role of concepts such as teleportation and telecommuting in the context of excess commuting research.

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APPENDIX A

Published papers and conference proceedings

Barr, S., Fraszczyk, A., Mulley, C., 2010. Excess travelling – what does it mean? New definition and a case study of excess commuters in Tyne and Wear. European Transport Research Review (2010) 2, 69-83.

Fraszczyk, A., Mulley, C., 2010. Do they travel too much? The definition of excess travel and a case study of excess travellers in Tyne and Wear, UK. 12th World Conference on Transport Research, 11-15 July, 2010 – Lisbon, Portugal. Conference proceedings.

Fraszczyk, A., Mulley, C, 2012. The trio of excess commuting parameters: time, cost and effort. UTSG Annual Conference, University of Aberdeen, 3-5 January 2012.

Fraszczyk, A., Mulley, C., 2012. Teleportation vs. commuting. Who might prefer to commute? Time Use Observatory, 21-23 March, 2012, Santiago de Chile (abstract).

Fraszczyk, A., Mulley, C., 2012. GIS as a tool for sample selection in a travel behaviour survey. RGS-IBG Annual International Conference, University of Edinburgh, 3-5 July 2012 (abstract).

Fraszczyk, A., Mulley, C., 2014. GIS as a tool for selection of sample areas in a travel behaviour survey. Journal of Transport Geography 34 (2014), 233–242 (abstract).

European Transport Research Review (2010) 2, 69-83

Excess travelling – what does it mean? New definition and a case study of excess commuters in Tyne and Wear.

Dr Stuart Barr, Newcastle University
Anna Fraszczyk, Newcastle University
Prof. Corinne Mulley, The University of Sydney

Abstract

This paper has four main aims. Firstly, to undertake a critical review of existing definitions of excess travel focused on travel to work and hence to present a new definition which takes account of important developments in the public transport literature. This is used as the basis to identify whether excess travellers exist in the journey to work context and to identify differences between excess commuters and non-excess travellers. This is undertaken using two different methodologies of sample selection and analysis: innovative sample selection using GIS to identify hotspots is compared with destination sampling and for analysis the use of time and cost calculations are compared with generalised cost. The results show that a small number of excess commuters do exist and that whilst these travellers admit to a variety of benefits they can get from travel, most of them are excess travelling voluntarily with many factors are influencing their travel choices. Application of this research is that the better understanding of excess travel phenomenon in daily commute will allow for exploring public transport providers' (PTP) policy to encourage sustainable transport patterns of commuting by meeting travellers' expectations and, in the long run, marketing excess travel time into activity time what potentially might create extra revenue for PTP.

12th WCTR, July 11-15, 2010 – Lisbon, Portugal.

Conference proceedings

Do they travel too much? A definition of excess travel and a case study of excess travellers in Tyne and Wear, UK

Anna Fraszczyk, Newcastle University

Prof. Corinne Mulley, The University of Sydney

Abstract

Excess travel is a concept that has been the focus of research in the last 30 years. Excess travel recognises that for some people there is some utility from their travel itself and this has led to a recent renaissance of interest in this theory with developments in empirical research on the value of time (VOT) which currently assumes travel is all disutility. Whilst the literature has concentrated on non-work trips, this paper reports a study on commuting behaviour where it might be expected to find less excess travellers.

The excess travel research based on commuting reported here aims: to review existing definitions of excess travel and present a new improved one; identify if excess travellers exist at all and if so, are there differences between excess travellers and non-excess travellers in terms of their attitudes to travel and socio-economic characteristics.

The research is based on two different methods of identifying excess travellers and both show a small number of excess travellers in their commute. A better understanding of excess commuting is a pre-requisite to encourage improvements in sustainable transport patterns of commuting and for public transport providers to market excess travel time into activity time with potential to create extra revenue.

This paper is based on a pilot study and a small sample of respondents. The aim of this stage was to test ideas and verify analysis which will be used in the main study.

UTSG Annual Conference, University of Aberdeen, 3-5 January 2012.

Conference proceedings

The trio of excess travel parameters: time, cost and effort.

Anna Fraszczyk, Newcastle University

Prof. Corinne Mulley, The University of Sydney

Abstract

Recently, researchers have shown an increased interest in an excess commuting phenomenon (Rodriguez, 2004; Ma and Banister, 2006; Murphy, 2009). However to date the main focus has been using either a time or distance-based methodology with little or no role given to the monetary cost and physical effort involved in commuting. This paper is based on data collected in 2010 in Tyne and Wear, UK to examine excess commuting from the three different perspectives of: time, cost and effort. A relatively new definition of excess travel (Barr, Fraszczyk and Mulley, 2010) provides the basis of identification. The results suggest that the excess exists, albeit on a small scale for commuting. The exact proportion of excess commuters depends on the methodology used and the variables considered.

Time Use Observatory, Santiago de Chile, 21-23 March 2012

Teleportation vs. commuting. Who might prefer to commute?

(extended abstract)

Anna Fraszczyk, Newcastle University

Prof Corinne Mulley, The University of Sydney

Introduction

This paper is centred on the concept of "teleportation" to investigate how this is viewed by people who physically commute to work. Teleportation is defined as "the movement of objects from one place to another without travelling through the space" (Fraszczyk, 2010). Transport studies have regularly addressed questions of the individual's readiness to change travel to work modes but, despite qualitative study evidence, there is no quantified evidence examining why some commuters prefer actual travel to the alternative of teleportation. The reasons, once identified, will contribute to the wider understanding of peoples' travel behaviour and travel mode choices not only at present but also to the understanding of alternative transport option choices in the future.

Qualitative evidence for teleportation fans or teleportation sceptics is offered in the literature. Watts and Urry (2008), for example, suggested various reasons why the activity of physical commuting is ranked higher than teleportation by some commuters. They identified "time spent on business and commuter journeys was thought to be very valuable and rarely was teleportation viewed as acceptable" (Watts and Urry, 2008, p. 865). Their main conclusion was that commuting offers costless transition time which could be used for "planning, de-stressing, and sorting things out in ones head" (Watts and Urry, 2008, p. 866) and this was important to balance work and family life. In addition, the commute was a transition time "between responsibilities and social practices" (p. 866). Similar conclusions were formed by Jain and Lyons (2008) who suggested that travel/transition time is a gift. These studies suggest commuters need time for themselves, and even if it were possible to transfer travel time into work time (e.g. mobile offices) or if teleportation was possible, some commuters would need some time to switch on/off and prepare for the role they undertake at the journeys' destination. However, whilst the qualitative studies offer important insights, they do not answer the question of "who" might prefer actual travel to teleportation in terms of socio-economic and attitudinal characteristics. This paper aims to fill this gap.

Methodology and proposed analysis

This paper focuses on teleportation in the commuting context based on a UK case-study in Tyne and Wear in the north-east of England. It presents quantitative evidence on the characteristics of commuters who are for and against teleportation. The data come from part of a wider study looking at excess travel more generally in which a question was asked as part of "Travel to work" questionnaire distributed in 2010 in Tyne and Wear.

The reasons behind why a commuter might answer that teleportation would be good or bad for them are examined from the response of a sample of 223

commuters. In this sample, the question about willingness to teleport split respondents into two groups, with two thirds (68%) being against and one third (32%) in support. As part of a survey with detailed socio-economic and attitudinal questions, these responses can be compared in detail to identify if there are significant differences between the groups.

An analysis of travel time use, attitudes towards travel and the propensity to "excess travel" (Fraszczyk and Mulley, 2010), suggests that the teleportation sceptics (TS) in the sample are content with the amount of time they spend on commuting (27 minutes on average) as compared to their ideal one-way commute time of 23 minutes on average. This ideal commute time is confirmed by earlier studies where authors identified 16 minutes (Mokhtarian and Salomon, 2001) or 20-30 minutes (Watts and Urry, 2008) as ideal one-way commute time.

Most of the TS (39% vs. 26) in the sample tend to use public transport to get to work. They are also more likely go to work by cycle (13% vs. 3%) or by walking (7% vs. 3%) than teleportation fans (TF). These aggregate statistics also reveal that TS find commuting gives them the opportunity to relax (30%), switch off (38%) and exercise (31%). But the TS respondents on average spend less money on commuting (£1.27 vs. £1.63) and travel shorter distances (8.27km vs. 11.58km) than TF which may explain why TF are more pro-teleportation.

This paper will use statistical analysis to investigate reasons behind people's willingness to use teleportation as an alternative to actual travel in the commute. It will build on the observations of Watts and Urry (2008) and Jain and Lyons (2008) who noticed, when asking teleportation questions in focus groups, the first answers were often positive. But that detailed discussions about the benefits of travelling and travel time caused a shift by participants back towards preferring actual travel. Ory and Mokhtarian (2005, p. 121) also suggest that questions about teleportation have the potential to "identify strengths of the various reasons of travelling". Qualitative studies provide significant context but are unable to explain why one commuter might prefer telecommuting and another not. This paper proposes that a quantitative study, focussed on commuting, can provide this evidence on with a proper segmentation of the population can be based which would allow operators and authorities to shape marketing strategies aimed at both increasing public transport use and making it more "useful" for commuters. The more we know about the needs of commuters the easier it is to design better public transport and promote it to new potential users.

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RGS-IBG Annual International Conference, University of Edinburgh,
3-5 July 2012

GIS as a tool for sample selection in a travel behaviour survey

Anna Fraszczyk, Newcastle University
Prof Corinne Mulley, The University of Sydney

Abstract

Whilst Geographical Information Systems (GIS) are now more commonly used in transport research and modelling, GIS techniques were used in this study to select homogeneous sample areas (in terms of geography and census attributes) for data collection. For this purpose, a GIS mapping system for Tyne and Wear, UK was built. The system included topographic maps of the area, boundary maps of Lower Super Output Areas (LSOAs) and aggregated census statistics datasets for LSOAs. Criteria relating to census attributes and the nature of transport were employed to identify "hotspots" by GIS enquiry to provide suitably matching areas.

The study was concerned with identifying commuters and the GIS "hotspots" approach allowed the identification of areas where there were multiple alternatives for different travel to work. The pilot study identified that the GIS approach was superior in collecting a balanced sample, as compared to an employment based destination survey. This paper explores the benefits and costs of the alternative approaches which include the need to target households with paper based surveys in the origin-based (home) sample after identification by GIS and requires significant preparation of the data as compared to the alternative of a destination based sample which allows the collection of data through an on-line survey.

The paper concludes by identifying GIS as an important tool in selecting a sample area for data collection using multiple criteria but that plans for data collection need to be flexibly constructed to overcome unexpected challenges.

Journal of Transport Geography 34 (2014), 233–242

GIS as a tool for selection of sample areas in a travel behaviour survey.

Anna Fraszczyk, Newcastle University
Prof. Corinne Mulley, The University of Sydney

Abstract

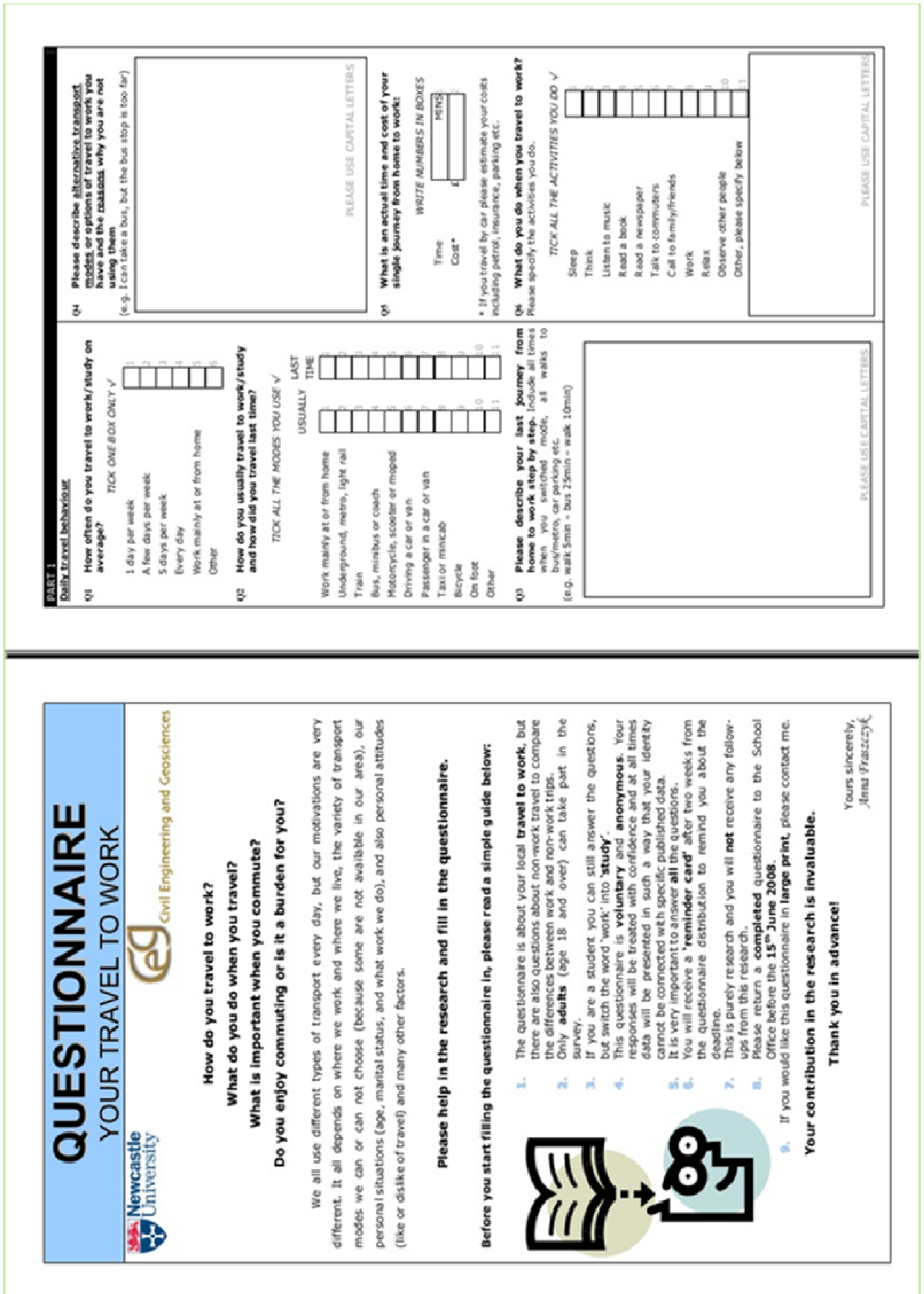
Whilst Geographical Information Systems (GIS) are now used more commonly in transport research and modelling, GIS techniques were used in this study to select similar sample areas (in terms of geography and census attributes) for data collection. For this purpose, a GIS mapping system for Tyne and Wear, UK, was built. The system included topographic maps of the area, boundary maps of Lower Super Output Areas (LSOA), and aggregated census statistics datasets for LSOAs. Criteria relating to census attributes and the nature of transport were employed to identify 'hotspots' by GIS enquiry to provide suitably matching areas, which then formed the basis of the sampling frame.

The research project was concerned with commuters' travel choices and so the study needed to identify commuters. In this case-study context, it is not possible to select fully homogeneous areas, so the GIS 'hotspots' approach allowed the identification of areas where there were a high concentration of commuters with multiple alternatives for travel to work. A pilot study showed that the GIS origin-based approach was good in collecting a balanced sample, as compared to an employment-based destination survey. This paper explores the benefits and costs of these origin- and destination-based approaches. In the origin-based home sample, households with paper-based surveys were targeted after identification by GIS. This origin approach requires more data preparation compared to the alternative of an employer-based, destination-based sample that could use online survey methodologies.

The paper concludes by identifying GIS as an important tool in selecting a sample area for data collection using multiple criteria, but argues that plans for data collection need to be flexibly constructed to overcome unexpected challenges. Although this paper focuses on a transport research case study, the methodology presented can be applied to survey design and selection of sample areas in other disciplines.

APPENDIX B

Pilot questionnaire



QUESTIONNAIRE

YOUR TRAVEL TO WORK

Newcastle University

Civil Engineering and Geosciences

How do you travel to work?

What do you do when you travel?

What is important when you commute?

Do you enjoy commuting or is it a burden for you?

We all use different types of transport every day, but our motivations are very different. It all depends on where we work and where we live, the variety of transport modes we can or can not choose (because some are not available in our area), our personal situations (age, marital status, and what work we do), and also personal attitudes (like or dislike of travel) and many other factors.

Please help in the research and fill in the questionnaire.

Before you start filling the questionnaire in, please read a simple guide below:

1. The questionnaire is about your local **travel to work**, but there are also questions about non-work travel to compare the differences between work and non-work trips.
2. Only **adults** (age 18 and over) can take part in the survey.
3. If you are a student you can still answer the questions, but switch the word 'work' into **'study'**.
4. This questionnaire is **voluntary** and **anonymous**. Your responses will be treated with confidence and at all times data will be presented in such a way that your identity cannot be connected with specific published data.
5. It is very important to answer **all** the questions.
6. You will receive a **'reminder card'** after two weeks from the questionnaire distribution to remind you about the deadline.
7. This is purely research and you will **not** receive any follow-ups from this research.
8. Please return a **completed** questionnaire to the School Office before the **15th June 2008**.
9. If you would like this questionnaire in **large print**, please contact me.

Your contribution in the research is invaluable.

Thank you in advance!

Yours sincerely,
Anna Fraszczyk

PART 1

Daily travel behaviour

Q1 **How often do you travel to work/study on average?**

TICK ONE BOX ONLY ✓

- 1 day per week
- A few days per week
- 5 days per week
- Every day
- Work mainly at or from home
- Other

Q2 **How do you usually travel to work/study and how did you travel last time?**

TICK ALL THE MODES YOU USE ✓

	USUALLY	LAST TIME
Work mainly at or from home		
Underground, metro, light rail		
Train		
Bus, minibus or coach		
Motorcycle, scooter or moped		
Driving a car or van		
Passenger in a car or van		
Taxi or minicab		
Bicycle		
On foot		
Other		

Q3 **Please describe your last journey from home to work step by step.** Include all times when you switched mode, all walks to bus/metro, car parking etc.
(e.g. walk 5min – bus 25min – walk 10min)

PLEASE USE CAPITAL LETTERS

Q4 **Please describe alternative transport modes or options of travel to work you have and the reasons why you are not using them**
(e.g. I can take a bus, but the bus stop is too far)

PLEASE USE CAPITAL LETTERS

Q5 **What is an actual time and cost of your single journey from home to work?**

WRITE NUMBERS IN BOXES

Time ____ MINS
Cost* £ ____

* If you travel by car please estimate your costs including petrol, insurance, parking etc.

Q6 **What do you do when you travel to work?**
Please specify the activities you do.

TICK ALL THE ACTIVITIES YOU DO ✓

- Sleep
- Think
- Listen to music
- Read a book
- Read a newspaper
- Talk to commuters
- Call to family/friends
- Work
- Relax
- Observe other people
- Other, please specify below

PLEASE USE CAPITAL LETTERS

PART 2

Opinions/preferences

In the next few questions you will be asked attitudinal statements. Please specify how important the variables stated below are when you chose how you travel to work and secondly non-work related travel.

Q1 How important are these when choosing your work and non-work travel?
(use 5-point scale where: 1-not important, 5-very important)

TICK ONE BOX FOR WORK AND NON-WORK TRAVEL √

Statement	Travel to work					Non-work travel				
	1	2	3	4	5	1	2	3	4	5
GOOD ACCESSIBILITY (e.g. good access to public transport; to the bus stop)	1	2	3	4	5	1	2	3	4	5
GOOD COMFORT (e.g. you need to feel comfortable during your journey)	1	2	3	4	5	1	2	3	4	5
CURIOSITY OF NEW PLACES (e.g. you like to have an opportunity to discover new places)	1	2	3	4	5	1	2	3	4	5
SHORT DISTANCE (your home-destination distance should be short)	1	2	3	4	5	1	2	3	4	5
HIGH INDEPENDENCE (e.g. you can choose which mode to use)	1	2	3	4	5	1	2	3	4	5
LOW PRICE (how important is the low cost of your journey for you?)	1	2	3	4	5	1	2	3	4	5
GOOD SAFETY (e.g. you want to feel safe whether on the bus or in the car)	1	2	3	4	5	1	2	3	4	5
SHORT TIME (e.g. quick journey between home and destination)	1	2	3	4	5	1	2	3	4	5
GOOD ENJOYMENT (e.g. you prefer a mode which can offer you enjoyment when you travel)	1	2	3	4	5	1	2	3	4	5

Q2 The amount of time you spend travelling to work is:

TICK ONE BOX ONLY √

1	2	3	4	5
Far too much	Too much	About the right	Too little	Far too little

Q3 What is, in your opinion, ideal one-way commute time?

WRITE NUMBER IN BOX

Time ____ MINS

Now you will be asked how much you agree or do not agree with the statements.

Q4 How true are these characteristics of your TRAVEL?

TICK ONE BOX FOR WORK AND NON-WORK TRAVEL √

Statement	Travel to work				Non-work travel			
	Not at all true	Not very true	Fairly true	Very true	Not at all true	Not very true	Fairly true	Very true
ENJOYMENT								
Sometimes I choose other route because I'm curious of the new route	1	2	3	4	1	2	3	4
When I travel I have a chance to enjoy scenic beauty	1	2	3	4	1	2	3	4
A travel time is a good time to relax	1	2	3	4	1	2	3	4
A travel time is a good time to think	1	2	3	4	1	2	3	4
A travel time is a good time to clear my head	1	2	3	4	1	2	3	4
A travel time is a good way to be alone	1	2	3	4	1	2	3	4
I like to travel more just for the fun	1	2	3	4	1	2	3	4
For me longer travel is an escape	1	2	3	4	1	2	3	4
I like to travel for travel's sake	1	2	3	4	1	2	3	4
I like exploring new places	1	2	3	4	1	2	3	4
Getting there is half the fun	1	2	3	4	1	2	3	4
My trip is a useful transition between home and work/destination	1	2	3	4	1	2	3	4
I like travelling alone	1	2	3	4	1	2	3	4
NEGATIVE								
I think my travel time is wasted!	1	2	3	4	1	2	3	4
I think I could use my travel time more productively	1	2	3	4	1	2	3	4
I think travel is boring	1	2	3	4	1	2	3	4
When I'm travelling every day is the same	1	2	3	4	1	2	3	4
The only good thing about travelling is arriving at your destination	1	2	3	4	1	2	3	4
My trip is a real hassle	1	2	3	4	1	2	3	4
I am uncomfortable being around people I don't know when I travel	1	2	3	4	1	2	3	4
POLICY								
We need more public transportation, even if taxes have to pay for a lot of the costs	1	2	3	4	1	2	3	4
I think about climate change/other environmental issues when making travel choices	1	2	3	4	1	2	3	4
If I could find quicker and cheaper way I would use it	1	2	3	4	1	2	3	4
CAR OWNERS ONLY								
I like to feel the sensation of speed when I'm driving	1	2	3	4	1	2	3	4
I feel proud of owning a vehicle	1	2	3	4	1	2	3	4
I'm driving because there are more of us in a car	1	2	3	4	1	2	3	4
I enjoy driving because I've got a good car	1	2	3	4	1	2	3	4

Q5 What kind of activities would you like to do during your commuting time, but you can't right now?

PLEASE USE CAPITAL LETTERS

Q6 What could public transport operators do to encourage you to use local services more often instead of private transport?

Please name activities or services which would convince you to use public transport more often. If you have any new ideas, never stated before, please feel free to write them below.

PLEASE USE CAPITAL LETTERS

Q7 If you could arrive at your work without commuting would you like to do it?

(e.g.: if you could use teleportation phenomenon like in "Star Trek" – science fiction film; teleportation is the movement of objects from one place to another without traveling through the space)

TICK ONE BOX ONLY √

Yes 1 No 2

Why?

PLEASE USE CAPITAL LETTERS

Q8 Have you switched your transport mode to work in the last few years? *TICK ONE BOX ONLY √*

Yes 1 No 2

If Yes go to Q9, if No skip to Q11

Q9 What was your previous transport mode to work? *PLEASE WRITE IN THE BOX*

Q10 Why have you switched to the present transport mode?

(e.g.: new job, new distance, new car etc.)

PLEASE USE CAPITAL LETTERS

Q11 Will any of the following encourage you to switch your transport mode to work (again)? Please specify your answer.

TICK APPROPRIATE BOXES √

	No	Yes	Please specify	
Cheaper price	1	1	If Yes, how much cheaper?	£
Quicker time	2	2	If Yes, how much quicker?	MINS
Shorter distance	3	3	If Yes, how much shorter?	KM
Combination of other factors	4	4	What other factors? Please specify below.	

PLEASE USE CAPITAL LETTERS

Q12 Have you ever heard about: *TICK ALL APPROPRIATE BOXES √*

	Yes	No
Smarter choices	1	1
Car share scheme	2	2
Car clubs	3	3
Any workplace travel plan	4	4
Transport Direct website	5	5
Other 'transport planner' tools	6	6

Q13 Do you use any of the above initiatives for work or non-work travel?

TICK ONE BOX ONLY √

Yes 1 No 2

If yes, where have you heard about them and why do you use them?

PLEASE USE CAPITAL LETTERS

Q14 Where do you look for information about local transport options? Please write below.

PLEASE USE CAPITAL LETTERS

PART 3

Geographical data

Q1 Please write the postcode of your: ORIGIN (home)

DESTINATION (work)

If you don't know the postcode of your workplace, please write the address below

PLEASE USE CAPITAL LETTERS

Q2 What is the type of area you live in? *TICK ONE BOX ONLY √*

Rural 1 Urban 2

Q3 What do you think about a level of transport infrastructure in your area?

(e.g. condition of roads, traffic jams, transport links in your area)

1	2	3	4	5
Very poor	Poor	Average	Good	Excellent

Your additional comments about transport infrastructure:

PLEASE USE CAPITAL LETTERS

Q4 What do you think about a level of transport accessibility in your area?

(i.e. number of buses, frequency; do you have easy access to public transport?)

1	2	3	4	5
Very poor	Poor	Average	Good	Excellent

Your additional comments about transport accessibility:

PLEASE USE CAPITAL LETTERS

PART 4

Socio-economic data

Q1 Your gender *TICK ONE BOX ONLY √*

Male [1] Female [2]

Q2 Your age

TICK ONE BOX ONLY √

Age	
23 or younger	1
24-40	2
41-64	3
65-74	4
75 or older	5

Q3 Your marital status

TICK ONE BOX ONLY √

Marital status (all people aged 16 and over)	
Single (never married)	1
Married or re-married	2
Separated or divorced	3
Widowed	4

Q4 What is your economic activity

TICK ALL APPROPRIATE BOXES √

Specification	Part time	Full time	Self employed
Higher Managerial and Professional (e.g. employers in large organisations, managerial occupations)	1	1	1
Lower Managerial and Professional	2	2	2
Supervisor, production worker, skilled trade (or similar)	3	3	3
Clerical, retail staff (or other routine)	4	4	4
Never Worked and Long-Term **Unemployed**	5	5	5
Student	6	6	6
Occupations not stated or inadequately described	7	7	7

Q5 Number of people living in household:

TICK ONE BOX ONLY √

1 person	1
2 people	2
3 people	3
4 people	4
5 or more people	5

Q7 Do you have a driving license?

TICK ONE BOX ONLY √

Yes [1] No [2]

Q8 Number of cars or vans in the household

TICK ONE BOX ONLY √

Cars or vans	
None	1
One	2
Two	3
Three	4
Four or more	5

Q9 How long have you lived at the present address?

WRITE NUMBER OF MONTHS/YEARS IN BOX

[ ] MONTHS/YEARS

Q10 From where have you moved:

TICK ONE BOX ONLY √

Elsewhere in the North East	1
Elsewhere in the UK	2
Elsewhere abroad	3
Please specify which country	

PLEASE USE CAPITAL LETTERS

Q11 Why have you moved into your area?

PLEASE USE CAPITAL LETTERS

Q12 How long have you been employed in your present job?

WRITE NUMBER OF MONTHS/YEARS IN BOX

[ ] MONTHS/YEARS

THANK YOU!

When you finish please return the completed questionnaire to the School Office before the 15th June 2008.

Do you want to find out more?

Nowadays we spend a lot of time travelling. Policy makers have always assumed that travel is a derived demand. In other words, they assumed that travel time is wasted time and something to be minimised. They suggested that if only people could choose not to travel, they would do so. But recent research shows that not all of the people like the idea of telecommuting or teleportation. There are some individuals who will not give up travelling. Why? My challenge is to explore that issue. I believe that there are some people who simply enjoy travelling. But to prove that I need your help. My questionnaire will help to answer some of the research questions related to travel characteristics and in particular excess travel and explore the benefits derived by individuals experiencing excess travel.

The outcome of the research will help to design benefits to local communities by suggesting how to travel more efficiently, environmentally friendly and use their time more productively.

The project of my research is called:

Do we travel too much?

The determinants and quantification of excess travel using GIS based longitudinal survey

Thank you for taking part in the research!

We do appreciate it.

If you have any questions, please contact:

Anna Fraszczyk
PhD student
Transport Operations Research Group (TORG)
School of Civil Engineering and Geosciences
Newcastle University
Newcastle upon Tyne
NE1 7RU
UK
anna.fraszczyk@ncl.ac.uk

Newcastle University

Civil Engineering and Geosciences

YOUR COMMENTS:

PLEASE USE CAPITAL LETTERS

APPENDIX C
Pilot online questionnaire (e-mail)

From: school-of-gps-request@newcastle.ac.uk [mailto:school-of-gps-request@newcastle.ac.uk] **On Behalf Of** Penny Millington
Sent: 04 June 2008 12:12
To: school-of-gps@ncl.ac.uk
Subject: [school-of-gps] Transportation questionnaire Deadline of 18th June

Dear All,

As per my previous email please follow the link below to compolete this questionnaire, if you would like a hard copy or pdf version please let me know and I will get one to you.

Penny

Dear Sir/Madam,

My name is Anna Fraszczyk and I am a researcher at Newcastle University, developing a project about travel behaviour and local travel to work in Tyne and Wear.

At the University we are conducting a study to find out more about peoples travel behaviour, how people feel about the way they use different types of transport, whether they enjoy travelling, what kind of information they use when making travel choices and what are the differences in travellers' behaviour when undertaking work and non-work travel.

In my research I would like to ask the staff of the School of Geography, Politics and Sociology about their travel to work.

I have prepared a questionnaire which is part of the project called: 'Do we travel too much? The determinants and quantification of excess travel using GIS based longitudinal survey'. The School of Geography, Politics and Sociology has been selected for the pilot survey because: 1) the number of employees (around 100) in the School is relevant to the size of the sample I require for the study; 2) the localisation of the School is close to a variety of transport links (bus, metro, car). I would be very grateful if you could fill in the questionnaire for me. The questionnaire is addressed to all the employees in the School, academic, research and technical staff. It will take about 20 minutes to complete the survey and all the responses are essential to my research. Please be assured that all information you give will be held confidentially to the project and there is no way in which your questionnaire can be identified as coming from you.

You can access the questionaire in 3 ways:

1) online: http://www.smart-survey.co.uk/v.asp?i=5571ivghq
2) PDF file attached, you can print and return to the box in the School of GPS
3) hard copy - is available on request

Please complete the questionnaire and return before 15 June 2008.

If you have any questions, please contact me via e-mail.
Thank you in advance!

Yours sincerely,
Anna Fraszczyk

Anna Fraszczyk

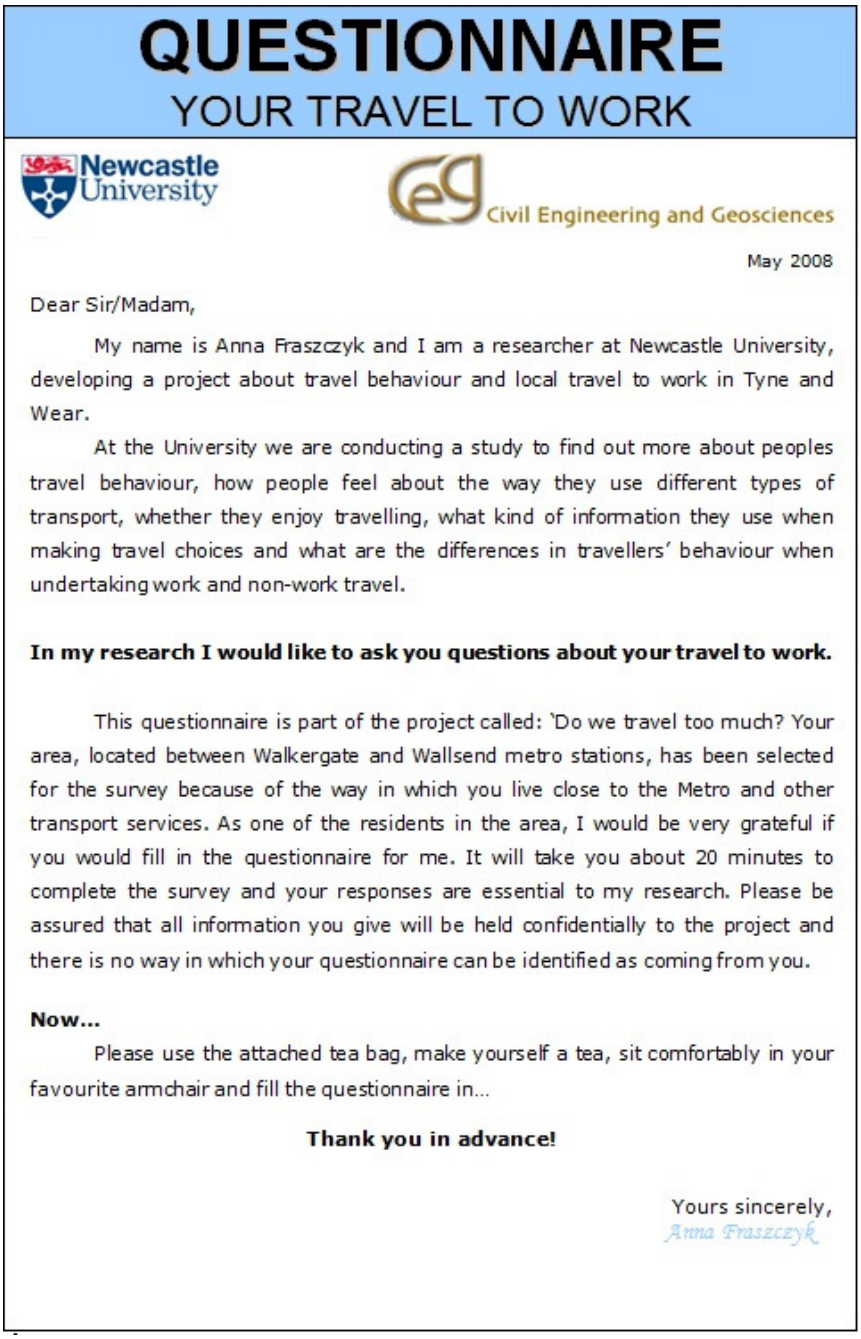
PhD student
Transport Operations Research Group (TORG) School of Civil Engineering and Geosciences
Newcastle University Newcastle upon Tyne

NE1 7RU
UK
anna.fraszczyk@ncl.ac.uk

Do you think we travel too much?
http://www.ceg.ncl.ac.uk/contact/pgprofile.aspx?scode=511

Kind Regards
Penny Millington, PA to Professor Andy Gillespie
School of Geography, Politics and Sociology
Newcastle university
5th Floor claremont tower
Newcastle Upon Tyne
NE1 7RU
tel: 222 3927
fax: 222 5421 penny.millington@ncl.ac.uk

APPENDIX D
Pilot covering letter



QUESTIONNAIRE
YOUR TRAVEL TO WORK

Newcastle University

Civil Engineering and Geosciences

May 2008

Dear Sir/Madam,

My name is Anna Fraszczyk and I am a researcher at Newcastle University, developing a project about travel behaviour and local travel to work in Tyne and Wear.

At the University we are conducting a study to find out more about peoples travel behaviour, how people feel about the way they use different types of transport, whether they enjoy travelling, what kind of information they use when making travel choices and what are the differences in travellers' behaviour when undertaking work and non-work travel.

In my research I would like to ask you questions about your travel to work.

This questionnaire is part of the project called: 'Do we travel too much? Your area, located between Walkergate and Wallsend metro stations, has been selected for the survey because of the way in which you live close to the Metro and other transport services. As one of the residents in the area, I would be very grateful if you would fill in the questionnaire for me. It will take you about 20 minutes to complete the survey and your responses are essential to my research. Please be assured that all information you give will be held confidentially to the project and there is no way in which your questionnaire can be identified as coming from you.

Now...

Please use the attached tea bag, make yourself a tea, sit comfortably in your favourite armchair and fill the questionnaire in...

Thank you in advance!

Yours sincerely,
Anna Fraszczyk

APPENDIX E

Pilot reminder card

QUESTIONNAIRE
YOUR TRAVEL TO WORK

If you have any questions, please contact:

Anna Fraszczyk
PhD student
Transport Operations Research Group (TORG)
School of Civil Engineering and Geosciences
Newcastle University
Newcastle upon Tyne
NE1 7RU
UK
anna.fraszczyk@ncl.ac.uk

REMINDER CARD

Civil Engineering and Geosciences

Newcastle University

June 2008

Dear Sir/Madam,

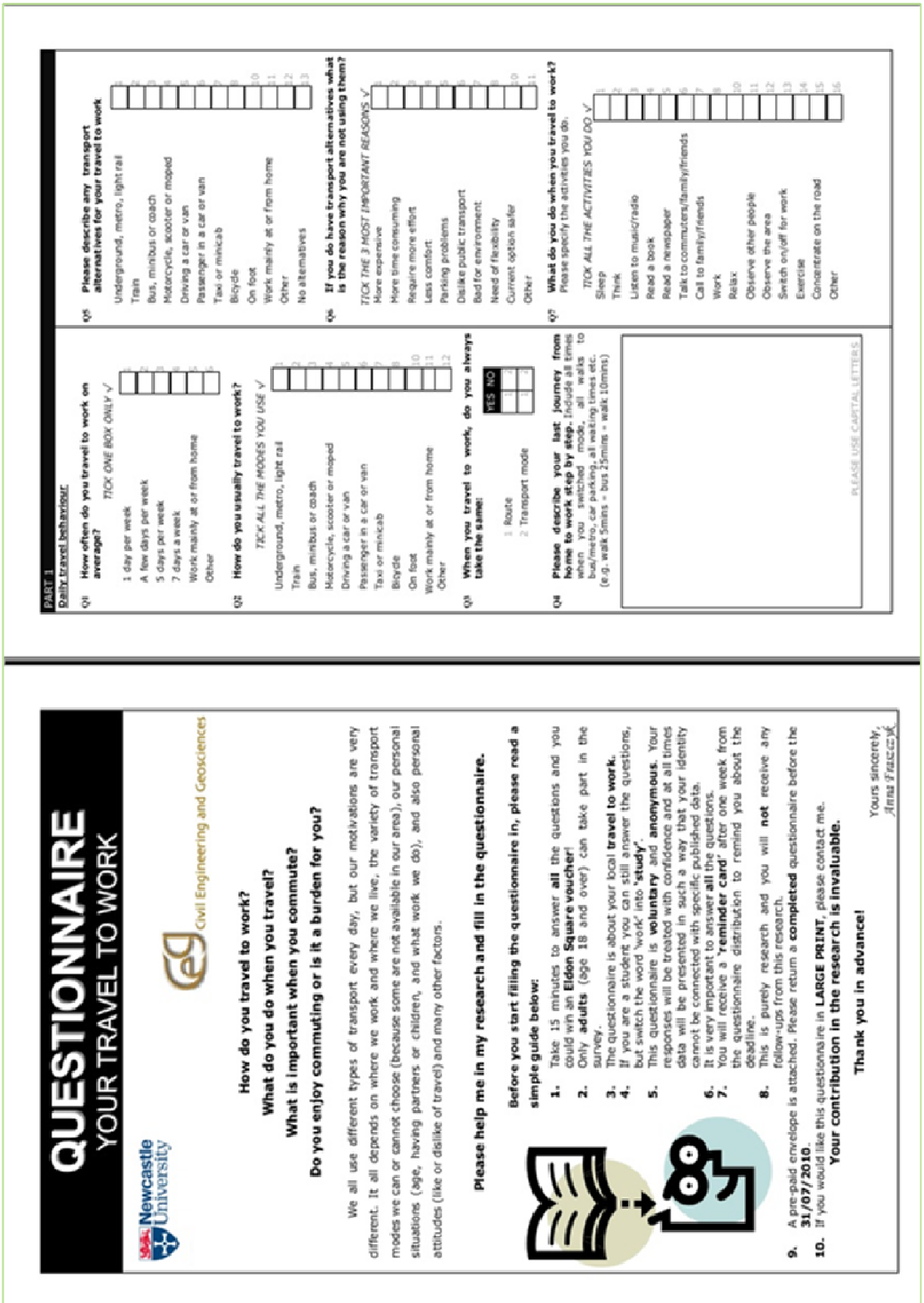
About one week ago you received an envelope with a questionnaire and return envelope inside. The questionnaire was related to your travel to work and is part of the project conducted at Newcastle University. If you haven't completed the questionnaire yet, please do so. It is very important and helpful in the further research. The deadline for completion is: **24th June 2008**. If you already sent the questionnaire back, thank you for your co-operation and apologies for this reminder. Your help is very much appreciated.

Thank you!

Yours sincerely,
Anna Fraszczyk

APPENDIX F

Main questionnaire



QUESTIONNAIRE
YOUR TRAVEL TO WORK

How do you travel to work?

What do you do when you travel?

What is important when you commute?

Do you enjoy commuting or is it a burden for you?

We all use different types of transport every day, but our motivations are very different. It all depends on where we work and where we live, the variety of transport modes we can or cannot choose (because some are not available in our area), our personal situations (age, having partners or children, and what work we do), and also personal attitudes (like or dislike of travel) and many other factors.

Please help me in my research and fill in the questionnaire.

Before you start filling the questionnaire in, please read a simple guide below:

1. Take 15 minutes to answer **all** the questions and you could win an **Eldon Square voucher**!
2. Only **adults** (age 18 and over) can take part in the survey.
3. The questionnaire is about your local **travel to work.**
4. If you are a student you can still answer the questions, but switch the word 'work' into **"study"**.
5. This questionnaire is **voluntary** and **anonymous**. Your responses will be treated with confidence and at all times data will be presented in such a way that your identity cannot be connected with specific published data.
6. It is very important to answer **all** the questions.
7. You will receive a **'reminder card'** after one week from the questionnaire distribution to remind you about the deadline.
8. This is purely research and you will **not** receive any follow-ups from this research.
9. A pre-paid envelope is attached. Please return a **completed** questionnaire before the **31/07/2010**.
10. If you would like this questionnaire in **LARGE PRINT**, please contact me.

Your contribution in the research is invaluable.

Thank you in advance!

Yours sincerely,
Anna Fraszczyk

PART 1

Daily travel behaviour:

Q1 **How often do you travel to work on average?**

TICK ONE BOX ONLY √

1 day per week 1
A few days per week 2
5 days per week 3
7 days a week 4
Work mainly at or from home 5
Other 6

Q2 **How do you usually travel to work?**

TICK ALL THE MODES YOU USE √

Underground, metro, light rail 1
Train 2
Bus, minibus or coach 3
Motorcycle, scooter or moped 4
Driving a car or van 5
Passenger in a car or van 6
Taxi or minicab 7
Bicycle 8
On foot 10
Work mainly at or from home 11
Other 12

Q3 **When you travel to work, do you always take the same:**

	YES	NO
1 Route	1	2
2 Transport mode	1	2

Q4 **Please describe your last journey from home to work step by step.** Include all times when you switched mode, all walks to bus/metro, car parking, all waiting times etc. (e.g. walk 5mins + bus 25mins + walk 10mins)

PLEASE USE CAPITAL LETTERS

Q5 **Please describe any transport alternatives for your travel to work**

Underground, metro, light rail 1
Train 2
Bus, minibus or coach 3
Motorcycle, scooter or moped 4
Driving a car or van 5
Passenger in a car or van 6
Taxi or minicab 7
Bicycle 8
On foot 10
Work mainly at or from home 11
Other 12
No alternatives 13

Q6 **If you do have transport alternatives what is the reason why you are not using them?**

TICK THE 3 MOST IMPORTANT REASONS √

More expensive 1
More time consuming 2
Require more effort 3
Less comfort 4
Parking problems 5
Dislike public transport 6
Bad for environment 7
Need of flexibility 8
Current option safer 10
Other 11

Q7 **What do you do when you travel to work?**
Please specify the activities you do.

TICK ALL THE ACTIVITIES YOU DO √

Sleep 1
Think 2
Listen to music/radio 3
Read a book 4
Read a newspaper 5
Talk to commuters/family/friends 6
Call to family/friends 7
Work 8
Relax 10
Observe other people 11
Observe the area 12
Switch on/off for work 13
Exercise 14
Concentrate on the road 15
Other 16

Q8 **What is an actual time and cost of your single journey from home to work:**

a) **Public transport users**

WRITE NUMBERS IN BOXES

Time: [ ] **MINS**

Cost: £ [ ] *

* If you use any travel pass, write down how much you assume this costs you for each work trip.

b) **Non-public transport users**

WRITE NUMBERS IN BOXES

Time: [ ] **MINS**

Cost: £ [ ]

Q9 **Have you included parking in your costs?** Yes [1] No [2]

Q10 **If YES in Q9, how much?**

PLEASE USE CAPITAL LETTERS

Q11 **If you travel by car, what costs (other than parking) have you included?**

PLEASE USE CAPITAL LETTERS

Q12 **How much effort do you spend:**

	Far too much	Too much	About the right	Too little	Far too little
Walking whilst commuting					
Waiting whilst commuting					
Carrying (work papers, shopping etc.) whilst commuting					

Q13 **How much OVERALL effort does your journey to work involve?**

1	2	3	4	5
Far too much	Too much	About the right	Too little	Far too little

Q14 **Do you plan your journey to work in advance?** Yes [1] No [2]

Q15 **If YES in Q14, what do you plan?**
(e.g. check the car, pack an ipod/book)

PLEASE USE CAPITAL LETTERS

Q16 **During your commute do you keep watching to check your progress?** Yes [1] No [2]

Q17 **Is your travel to work stressful?** Yes [1] No [2]

Q18 **If YES in Q17, is it stressful because you worry about:**

a) **being late for work?** Yes [1] No [2]

b) **your personal safety?** Yes [1] No [2]

c) **other, please specify:**

PLEASE USE CAPITAL LETTERS

PART 2

Opinions/preferences

In the next few questions you will be asked attitudinal statements. Please specify how important the variables stated below are when you chose how you travel to work.

Q1 **How important are these when choosing your travel to work?**
(use 5-point scale where: 1=not important, 5=very important)

TICK ONE BOX IN EACH ROW √

	Statement	1	2	3	4	5
1	**GOOD ACCESSIBILITY** (e.g. good access to public transport; to the bus stop)	1	2	3	4	5
2	**GOOD COMFORT** (e.g. you need to feel comfortable during your journey)	1	2	3	4	5
3	**CURIOSITY OF NEW PLACES** (e.g. you like to have an opportunity to discover new places)	1	2	3	4	5
4	**SHORT DISTANCE** (your home-destination distance should be short)	1	2	3	4	5
5	**HIGH INDEPENDENCE** (e.g. you can choose which mode to use)	1	2	3	4	5
6	**LOW PRICE** (how important is the low cost of your journey for you?)	1	2	3	4	5
7	**GOOD SAFETY** (e.g. you want to feel safe whether on the bus or in the car)	1	2	3	4	5
8	**SHORT TIME** (e.g. quick journey between home and destination)	1	2	3	4	5
9	**GOOD ENJOYMENT** (e.g. you prefer a mode which can offer you enjoyment when you travel)	1	2	3	4	5
10	**GOOD HEALTH** (e.g. you prefer a mode which can offer you health benefits)	1	2	3	4	5
11	**ENVIRONMENT** (e.g. you prefer a mode which offers good environmental outcomes)	1	2	3	4	5

Q2 **The amount of time you spend travelling to work is:**

TICK ONE BOX ONLY √

1	2	3	4	5
Far too much	Too much	About the right	Too little	Far too little

Q3 **What is, in your opinion, ideal one-way commute time?**

WRITE NUMBER IN BOX

Time [ ] **MINS**

Now you will be asked how much you agree or do not agree with the statements.

Q4 How true are these characteristics of your TRAVEL TO WORK?

TICK ONE BOX FOR TRAVEL √

	Statement	Not at all true	Not very true	Fairly true	Very true
	ENJOYMENT				
1	Sometimes I choose other route because I'm curious of the new route	1	2	3	4
2	When I travel I have a chance to enjoy scenic beauty	1	2	3	4
3	A travel time is a good time to relax	1	2	3	4
4	A travel time is a good time to think	1	2	3	4
5	A travel time is a good time to clear my head	1	2	3	4
6	A travel time is a good way to be alone	1	2	3	4
7	I like to travel more just for the fun	1	2	3	4
8	For me longer travel is an escape	1	2	3	4
9	I like to travel for travel's sake	1	2	3	4
10	I like exploring new places	1	2	3	4
11	Getting there is half the fun	1	2	3	4
12	My trip is a useful transition between home and work/destination	1	2	3	4
13	I like travelling alone	1	2	3	4
	NEGATIVE				
14	I think my travel time is wasted	1	2	3	4
15	I think I could use my travel time more productively	1	2	3	4
16	I think travel is boring	1	2	3	4
17	When I'm travelling every day is the same	1	2	3	4
18	The only good thing about travelling is arriving at your destination	1	2	3	4
19	My trip is a real hassle	1	2	3	4
20	I am uncomfortable being around people I don't know when I travel	1	2	3	4
	POLICY				
21	We need more public transportation, even if taxes have to pay for a lot of the costs	1	2	3	4
22	I think about climate change/other environmental issues when making travel choices	1	2	3	4
23	If I could find quicker and cheaper way I would use it	1	2	3	4
	CAR OWNERS ONLY				
24	I like to feel the sensation of speed when I'm driving	1	2	3	4
25	Driving a car gives me a feeling of pride in myself	1	2	3	4
26	I'm driving because there are more of us in a car	1	2	3	4
27	I enjoy driving because I've got a good car	1	2	3	4

Q5 Which activities would you like to do during your travel time, but you can't right now?

TICK THE 3 MOST IMPORTANT ACTIVITIES √

Do useful work		1
Use laptop		2
Use Internet		3
Read a newspaper		4
Listen to the news		5
Listen to music/radio		6
Watch TV		7
Read a book		8
Have a quiet space		10
Sleep		11
Other, please specify		12

PLEASE USE CAPITAL LETTERS

Q6 What could encourage you to use public transport services more often instead of private transport?

TICK THE 3 MOST IMPORTANT REASONS √

More direct routes		1
Safe bus stops		2
Up-to-date timetables		3
Electronic fare payment (like Oyster in London)		4
Upgraded vehicles		5
Regular & reliable service		6
Friendly staff		7
Cheaper fares		8
Other, please specify		10

PLEASE USE CAPITAL LETTERS

Q7 If you could arrive at your work without commuting would you like to do so?

(e.g. if you could use teleportation phenomenon like in "Star Trek" – science fiction film; teleportation is the movement of objects from one place to another without travelling through the space)

Yes 1 No 2

Q8 Regarding Q7, please answer:

Why YES?		or	Why NO?	
Just to try it	1		Doubt in it	7
Saves time	2		Need transition	8
Saves money	3		Like to exercise	10
Saves effort	4		Enjoy commute	11
Hate commute	5		Other	12
Other	6			

Q9 Have you switched your transport mode to work in the last 3 years while staying at the same address?

Yes 1 No 2

Q10 If YES in Q8, what was your previous transport mode to work?

Work mainly at or from home	1
Underground, metro, light rail	2
Train	3
Bus, minibus or coach	4
Motorcycle, scooter or moped	5
Driving a car or van	6
Passenger in a car or van	7
Taxi or minicab	8
Bicycle	10
On foot	11
Other	12

Q11 If YES in Q8, why have you switched to your current transport mode?

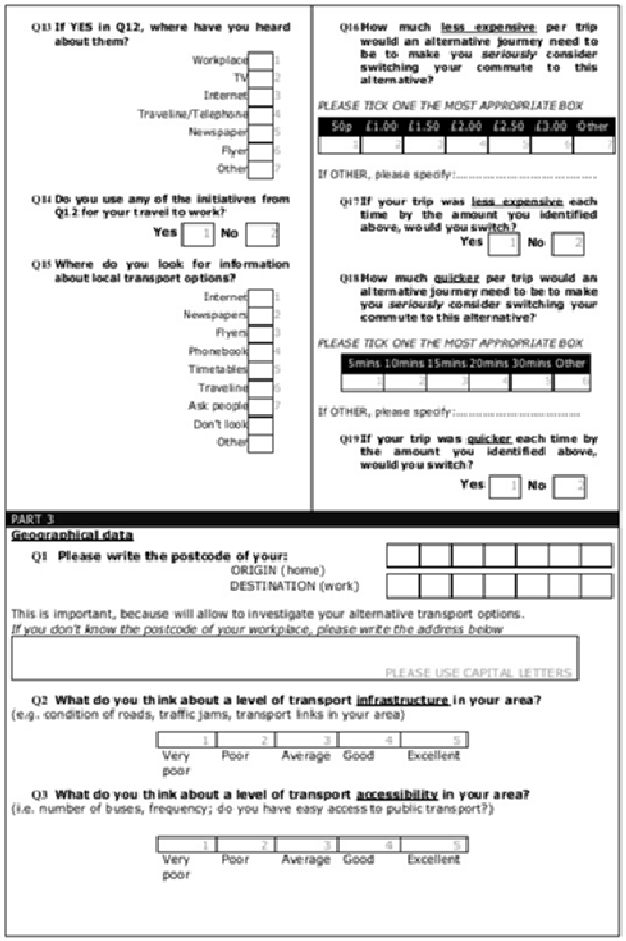
TICK THE ONE MAIN REASON √

Route changes	1
Current option cheaper	2
Bought a car	3
Need car at work	4
Comfort	5
Fitness/health	6
New job/distance	7
Travel with partner/colleague	8
Other	10

Q12 There are number of "transport planner tools" and schemes on the market. Please tick the boxes if you have heard about any specified below:

TICK ALL THE TOOLS YOU HAVE HEARD ABOUT √

Smarter choices	1
Car share scheme	2
Car clubs	3
Any workplace travel plan	4
Transport Direct website	5
Google Maps	6
Other "transport planner" tools	7



Q11 If YES in Q12, where have you heard about them?

Workplace 1
TV 2
Internet 3
Travelline/Telephone 4
Newspaper 5
Flyer 6
Other 7

Q14 Do you use any of the initiatives from Q12 for your travel to work?

Yes 1 No 2

Q15 Where do you look for information about local transport options?

Internet 1
Newspapers 2
Flyers 3
Phonebook 4
Timetables 5
Travelline 6
Ask people 7
Don't look
Other

Q16 How much less expensive per trip would an alternative journey need to be to make you seriously consider switching your commute to this alternative?

PLEASE TICK ONE THE MOST APPROPRIATE BOX

50p	£1.00	£1.50	£2.00	£2.50	£3.00	Other
1	2	3	4	5	6	7

If OTHER, please specify:.....

Q17 If your trip was less expensive each time by the amount you identified above, would you switch?

Yes 1 No 2

Q18 How much quicker per trip would an alternative journey need to be to make you seriously consider switching your commute to this alternative?

PLEASE TICK ONE THE MOST APPROPRIATE BOX

5mins	10mins	15mins	20mins	30mins	Other
1	2	3	4	5	6

If OTHER, please specify:.....

Q19 If your trip was quicker each time by the amount you identified above, would you switch?

Yes 1 No 2

PART 3

Geographical data

Q1 Please write the postcode of your:

ORIGIN (home)
DESTINATION (work)

This is important, because will allow to investigate your alternative transport options.
If you don't know the postcode of your workplace, please write the address below

PLEASE USE CAPITAL LETTERS

Q2 What do you think about a level of transport infrastructure in your area?
(e.g. condition of roads, traffic jams, transport links in your area)

1	2	3	4	5
Very poor	Poor	Average	Good	Excellent

Q3 What do you think about a level of transport accessibility in your area?
(i.e. number of buses, frequency; do you have easy access to public transport?)

1	2	3	4	5
Very poor	Poor	Average	Good	Excellent

PART 4

Socio-economic data

Q1 Your gender *TICK ONE BOX ONLY √*

Male 1 Female 2

Q2 Your age

TICK ONE BOX ONLY √

Age	
23 or younger	1
24-40	2
41-64	3
65-74	4
75 or older	5

Q3 Your marital status

TICK ONE BOX ONLY √

Marital status (all people aged 16 and over)	
Single (never married)	1
Married or re-married	2
Separated or divorced	3
Widowed	4

Q4 What is your economic activity

TICK ALL APPROPRIATE BOXES √

Specification	Part time	Full time	Self employed
Higher Managerial and Professional (e.g. employers in large organisations, managerial occupations)	1	1	1
Lower Managerial and Professional	2	2	2
Supervisor, production worker, skilled trade (or similar)	3	3	3
Clerical, retail staff (or other routine)	4	4	4
Never Worked and Long-Term **Unemployed**	5	5	5
Student	6	6	6
Occupations not stated or inadequately described	7	7	7

Q5 Number of people living in household:

TICK ONE BOX ONLY √

1 person	2 people	3 people	4 people	5 or more
1	2	3	4	5

Q7 Do you have a driving license?

TICK ONE BOX ONLY √

Yes 1 No 2

Q8 Number of cars or vans in the household

TICK ONE BOX ONLY √

Cars or vans	
None	1
One	2
Two	3
Three	4
Four or more	5

Q9 Do you have access to a car?

Yes 1 No 2

Q10 How long have you lived at the present address?

WRITE NUMBER OF YEARS IN BOX

YEARS

Q10 From where have you moved:

TICK ONE BOX ONLY √

Elsewhere in the North East	1
Elsewhere in the UK	2
Elsewhere abroad	3
Please specify which country	

PLEASE USE CAPITAL LETTERS

Q11 What is the reason why you have moved into your area?

Nice area	1
Work/university	2
Better house	3
Family/partner	4
Personal	5
Never moved	6
Other	7

Q12 How long have you been employed in your present job?

WRITE NUMBER OF YEARS IN BOX

YEARS

---THE END---

THANK YOU very much for taking your time to fill out this questionnaire. If you would like to be entered in the prize draw for one of five **£10 Eldon Square vouchers**, please provide your name and contact number/e-mail address in the box below. Please note that only questionnaires **FULLY** completed will enter the prize draw. Your details will not be used elsewhere.

PLEASE PUT YOUR NAME AND CONTACT DETAILS HERE

APPENDIX G

Main online questionnaire (Newsletter print screen)

Newcastle University

Civil Engineering and Geosciences

COMPLETE THE ATTACHED QUESTIONNAIRE AND WIN ONE OF FIVE £10 ELDON SQUARE VOUCHERS!!!

QUESTIONNAIRE
YOUR TRAVEL TO WORK

July 2010

Dear Sir/Madam,

My name is Anna Fraszczyk and I am a researcher at Newcastle University, developing a project about travel behaviour and local travel to work in Tyne and Wear.

At the University I am conducting a study to find out more about peoples travel behaviour, how people feel about the way they use different types of transport, whether they enjoy travelling, what kind of information they use when making travel choices and what are the differences in travellers' behaviour when undertaking work and non-work travel.

In my research I would like to ask you questions about your travel to work.

As a way of saying THANK YOU you could win one of five £10 Eldon Square vouchers if you fully complete your questionnaire.

This questionnaire is part of the project called: 'Do we travel too much?' You can find more details on the next page.

Your area has been selected for the survey because of the distance you live to the Metro and other transport services. As one of the residents in the area, I would be very grateful if you would fill in the questionnaire for me. It will take you about 15 minutes to complete the survey and your responses are essential to my research. Please be assured that all information you give will be held confidentially to the project and there is no way in which your questionnaire can be identified as coming from you. Deadline for submission is 31/07/2010.

Now...

Please use the attached pen, sit comfortably in your favourite armchair and fill the questionnaire in..

Thank you in advance!

Yours sincerely,
Anna Fraszczyk

PRIZE DRAW DETAILS

There is 5 vouchers £10 each for Eldon Square to be won. Only respondents who provide name and contact details will take part in the prize draw. The prizes will be drawn 1 month after submission deadline (31/07/2010). Afterwards all winners will be contacted within 1 week to arrange collection of the prizes.

Do you want to find out more?

Nowadays we spend a lot of time travelling. Policy makers have always assumed that travel is a derived demand. In other words, they assumed that travel time is wasted time and something to be minimised. They suggested that if only people could choose not to travel, they would do so. But recent research shows that not all of the people like the idea of telecommuting or teleportation. There are some individuals who will not give up travelling. Why? My challenge is to explore that issue. I believe that there are some people who simply enjoy travelling. My questionnaire will help to answer some of the research questions related to travel characteristics and in particular excess travel and explore the benefits derived by individuals experiencing excess travel.

The outcome of the research will help to design benefits to local communities by suggesting how to travel more efficiently, environmentally friendly and use their time more productively.

The project of my research is called:

Do we travel too much?

The determinants and quantification of excess travel using GIS based longitudinal survey

Thank you for taking part in the research!

We do appreciate it.

If you have any questions, please contact:
Anna Fraszczyk
PhD student
Transport Operations Research Group (TORG)
School of Civil Engineering and Geosciences
Newcastle University
Newcastle upon Tyne
NE1 7RU
UK
anna.fraszczyk@nd.ac.uk

Newcastle University

Civil Engineering and Geosciences

APPENDIX H
Covering letter

Newcastle University

Civil Engineering and Geosciences

REMINDER LETTER

REMINDER LETTER RE:

QUESTIONNAIRE

YOUR TRAVEL TO WORK

July 2010

Dear Sir/Madam,

About two weeks ago you received an envelope with a questionnaire and return envelope inside. The questionnaire was related to your travel to work and is part of a project being undertaken at Newcastle University. If you haven't completed the questionnaire yet, please do so as every contribution is extremely important to the research. The deadline for completion is: **31/07/2010** and you could win one of five £10 **Eldon Square vouchers**. If you have already sent the questionnaire back, thank you for your co-operation and my apologies for this reminder.

Your help is very much appreciated.

Thank you!

Yours sincerely,

Anna Fraszczyk

PRIZE DRAW DETAILS

There is 5 vouchers £10 each for Eldon Square to be won. Only respondents who provide name and contact details will take part in the prize draw. The prizes will be drawn 1 month after submission deadline (31/07/2010). Afterwards all winners will be contacted within 1 week to arrange collection of the prizes.

If you have any questions, please contact:

Anna Fraszczyk
PhD student
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NE1 7RU
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anna.fraszczyk@ncl.ac.uk

APPENDIX J

Car journey cost by Transport Direct

Example of pure cost for car option according to www.transportdirect.info accessed on 25/02/2011:

Fuel cost (approx.):		**£1**		Note: The fuel costs are approximate and may vary by 50% or more depending on factors such as weather, driving style, high congestion levels, number of passengers and tyre pressures. We assume you have a medium sized petrol-engined car unless you have specified your own values for car size and fuel type or fuel consumption on the car details input pages.
Running cost (approx.):		**£2**		Note: The running costs are based on information from the RAC for a car that is up to three years old and has averaged 12000 miles/year. We assume you have a medium sized petrol-engined car unless you have specified your own values for car size and fuel type. More detailed information for running a petrol or diesel car can be obtained from the AA or RAC.
TOTAL COST for outward journey (£)		**£3**		
Note: Reduced charges/tolls/fares may apply for return journeys. For example, return fares may be available for ferry crossings.				

APPENDIX K

Internal "excess travel" definition survey

After an extensive literature review and a few interviews with other PhD researchers in transport a draft of a new definition of excess travel was emailed to ten senior transport researchers in a School of Civil Engineering and Geosciences at Newcastle University. The aim of this exercise was to test the understanding of excess travel concept amongst the internal group. As experienced academics, they were invited to comment on the definition. The original definition was that:

> Excess travel occurs when travel, which is a process of moving from the origin to the destination point, is more expensive, more distant (longer route is chosen), needs more effort (i.e. changing modes) and is more time-consuming than the most timely and costly effective route. All the variables can play together or separately. Different factors can cause the phenomenon, i.e. finances, enjoyment. Excess travel is also any travel not derived from the utility of the destination only, but from the positive utility for travel itself or simply affinity for travel.
>
> Personal email sent on 17 April 2007

Four e-mail responses were received and the main points related to the draft definition highlighted by the transport researchers were that:

- Essential travel could include different levels: the bare minimum, the level of travel that makes life comfortable and excess travel which is not needed for existence but makes life worthwhile. [Respondent 1]
- Another view is to consider whether excess travel is a personal matter or whether one should consider society and government, i.e. carbon footprint and sustainability could be linked to excess travel. [Respondent 1]
- Slow cheap travel would not be excess nor would fast expensive. The definition needs to say that travel involves money, time and effort. [Respondent 2]
- The draft definition compares four variables (money, distance, effort and time) against two (time and money) and I am not sure how you measure effort. [Respondent 3]
- The definition could be: excess travel occurs when travel is more expensive than the most cheapest route, longer than the shortest route, or takes more time that the quickest route. Analyse the conflict between these three relatively straightforward comparisons. [Respondent 3]

- Consider carefully the various meanings of the word “excess”. The following phrases seem interesting: beyond normal, sufficient or permitted limits. [Respondent 4]

The main conclusion out of this small research was that people, transport researchers in this case, have different opinions and perceptions on the excess travel (commuting) phenomenon. However, the most common thought was that the new definition should talk about parameters of time, distance, cost and effort and compare these.

APPENDIX L

Attributes of Lower Super Output Areas

Field	Value	Field	Value
England_low_soa_2001_area. ZONECODE	E01008788	census_1_4_soa.ALL_PEOPLE	1554
England_low_soa_2001_area. Shape	Polygon	census_1_4_soa.ALL_PEOP_1	1318
England_low_soa_2001_area. POPNORTH	558748	census_17_soa.ZONE_NAME	Sunderland
England_low_soa_2001_area. POPEAST	439884	census_17_soa.ZONE_CODE	E01008788
England_low_soa_2001_area. NAME	Sunderland 006C	census_17_soa.OID	626
England_low_soa_2001_area. LABEL	06CME0100878 8	census_17_soa.ALL_HOUSEH	748
England_low_soa_2001_area. GEONORTH	558774	census_17_soa.ALL_CARS	614
England_low_soa_2001_area. GEOEAST	439870	census_17_soa.4>_CARS	0
England_low_soa_2001_area. FID	523	census_17_soa.3_CARS	2
census_9a_soa.ZONE_NAME	Sunderlan	census_17_soa.2_CARS	12
census_9a_soa.ZONE_CODE	E01008788	census_17_soa.1_CAR	52
census_9a_soa.UNEMPLOYE	3.4	census_17_soa.0_CAR	34
census_9a_soa.UNEMPLOY_	3.1	census_15_soa.ZONE_NAME	Sunderland
census_9a_soa.STUDENT	2.9	census_15_soa.ZONE_CODE	E01008788
census_9a_soa.SICK/DISAB	8.9	census_15_soa.TRAIN	3
census_9a_soa.SELF-EMPLO	4	census_15_soa.TAXI	1
census_9a_soa.RETIRED	15.8	census_15_soa.PTU_-_CAR	7
census_9a_soa.PART-TIME	11.5	census_15_soa.PTU_+_CAR	12
census_9a_soa.OTHER	1.7	census_15_soa.PASSENGER	10
census_9a_soa.OID	626	census_15_soa.OTHER	0
census_9a_soa.LAH/F	5.2	census_15_soa.ON_FOOT	10
census_9a_soa.FULL-TIME_	1.2	census_15_soa.OID	626
census_9a_soa.FULL-TIME	45.5	census_15_soa.MOTORCYCL	1
census_9a_soa.ALL_PEOPLE	1212	census_15_soa.LIGHT_RAIL	0
census_6.ZONE_NAME	Sunderlan	census_15_soa.DRIVING	52
census_6.ZONE_CODE	E01008788	census_15_soa.BUS	16
census_6.WB_CARIBBE	0	census_15_soa.BICYCLE	1
census_6.WB_AFRICAN	0.2	census_15_soa.AV_DISTANC	13
census_6.W_IRISH	0.2	census_15_soa.AT_HOME	6
census_6.W_BRITISH	97.6	census_15_soa.ALL_PEOPLE	754
census_6.W_ASIAN	0.2	census_11a_soa.ZONE_NAME	Sunderland
census_6.PAKISTANI	0.2	census_11a_soa.ZONE_CODE	E01008788
census_6.OTHER_W	0.3	census_11a_soa.OID	626
census_6.OTHER_MIXE	0	census_11a_soa.C9	3.8
census_6.OTHER_ETHN	0	census_11a_soa.C8	16.3
census_6.OTHER_BLAC	0	census_11a_soa.C7	3.7
census_6.OTHER_ASIA	0	census_11a_soa.C6	2
census_6.OID	626	census_11a_soa.C5	17.4
census_6.INDIAN	0.3	census_11a_soa.C4	0
census_6.CHINESE	1	census_11a_soa.C3	0
census_6.CARIBBEAN	0	census_11a_soa.C2	0.5
census_6.BANGLADESH	0	census_11a_soa.C16	6.6
census_6.ALL_PEOPLE	1555	census_11a_soa.C15	13.8
census_6.AFRICAN	0	census_11a_soa.C14	6.4
census_1_4_soa.ZONE_NAM	Sunderland	census_11a_soa.C13	7.7
census_1_4_soa.ZONE_COD	E01008788	census_11a_soa.C12	5.2
census_1_4_soa.WIDOWED	8	census_11a_soa.C11	5.7

census_1_4_soa.SINGLE	33	census_11a_soa.C10	10.9
census_1_4_soa.SEPARATE	3	census_11a_soa.ALL_PEOPLE	754
census_1_4_soa.RE-	5		
census_1_4_soa.OID	626		
census_1_4_soa.MARRIED	43		
census_1_4_soa.MALES	47		
census_1_4_soa.FEMALES	53		
census_1_4_soa.DIVORCED	9		

Table L.1 A list of LSOA attributes imported from CasWeb with value examples for Area "F" Seaburn.

APPENDIX M

Results for the pilot study

Parameter	Alternative option	Sample size	Average % difference	Number of Excess Travellers in the pilot study with				
				>= 5% savings	>= 10% savings	>= 15% savings	>=20% savings	>= 50% savings
Time	Car	n=50	-16%	36	34	32	32	6
	PT1	n=65	-63%	23	20	17	17	2
	PT2	n=65	-64%	22	18	15	12	2
Cost	Car	-	n/a	n/a	n/a	n/a	n/a	n/a
	PT1	n=47	25%	58	54	53	47	32
	PT2	n=47	17%	46	42	42	41	22
Gen cost	Car	n=50	-3%	42	40	38	26	2
	PT1	n=65	-55%	18	18	14	12	0
	PT2	n=65	-61%	22	14	11	9	0

Table M.1 Number of excess travellers in the pilot study for different percentages of savings when comparing self-reported option with three alternative journeys proposed. The option used in the analysis is highlighted in green.

Category	Option	Walker-ville n=45 [% of total sample]	the GPS[1] n=40 [% of total sample]	Total sample n=85 [%]
Gender	Male	16	14	31
	Female	34	33	67
	No response	2	0	2
Age	23 or younger	2	2	5
	24-40	12	28	40
	41-64	36	16	53
	65-74	1	0	1
	75 and older	1	0	1
Marital Status	Single (never married)	8	19	27
	Married or re-married	38	26	64
	Separated or divorced	7	2	9
Economic Activity	Higher and Lower Managerial and Professional	25	24	48
	Supervisor, production worker, skilled trade	5	1	6
	No response	1	1	2
	Clerical, retail staff	16	6	22
	Student	1	11	12
	Occupations not stated or inadequately described	5	5	9
Number of People Living in Household	1 person	4	7	11
	2 people	20	20	40
	3 people	15	12	27
	4 people	8	8	16
	5 or more people	6	0	6
Driving Licence	Yes	42	38	80
	No	11	9	20
Number of Cars or vans in Household	None	2	12	14
	1 car	31	22	53
	2 cars	18	11	28
	3 cars	2	2	5

Table M.2 Socio-economic characteristics of the pilot sample.

[1]the GPS – School of Geography, Politics and Sociology, Newcastle University.

Description	Option	Unit	Respondent number 10	% of self-reported results
Self-reported option	Self-reported	Time [mins]	85	100
		Cost [£]	8.00	100
Public transport options with an annual ticket price	Public Transport Option 1	Time [mins]	59	69
		Cost [£]	5.49	68
	Public Transport Option 2	Time [mins]	67	78
		Cost [£]	4.25	63
Public transport options with a daily ticket price	Public Transport Option 1	Time [mins]	59	69
		Cost [£]	6.70	83
	Public Transport Option 2	Time [mins]	67	78
		Cost [£]	5.70	71

Table M.3 Time and cost of self-reported and public transport options and excess travel results for illustrative respondent 10 from pilot sample (by using "pure time and cost" method).

Description	Option	Unit	Respondent number 10	% of self-reported results
Self-reported option	Self-reported	Time [mins]	85	100
		Cost [£]	8	
Generalised cost (for daily ticket price)	Self-reported	Time [mins]	92.46	100
		Cost [£]	7.77	
	Public Transport Option 1	Time [mins]	70.52	76
		Cost [£]	5.92	
	Public Transport Option 2	Time [mins]	71.46	77
		Cost [£]	6.00	

Table M.4 Time and cost of self-reported and public transport options and excess travel results for illustrative respondent 10 from the pilot sample (by using "generalised cost" method with minimal values of weights).

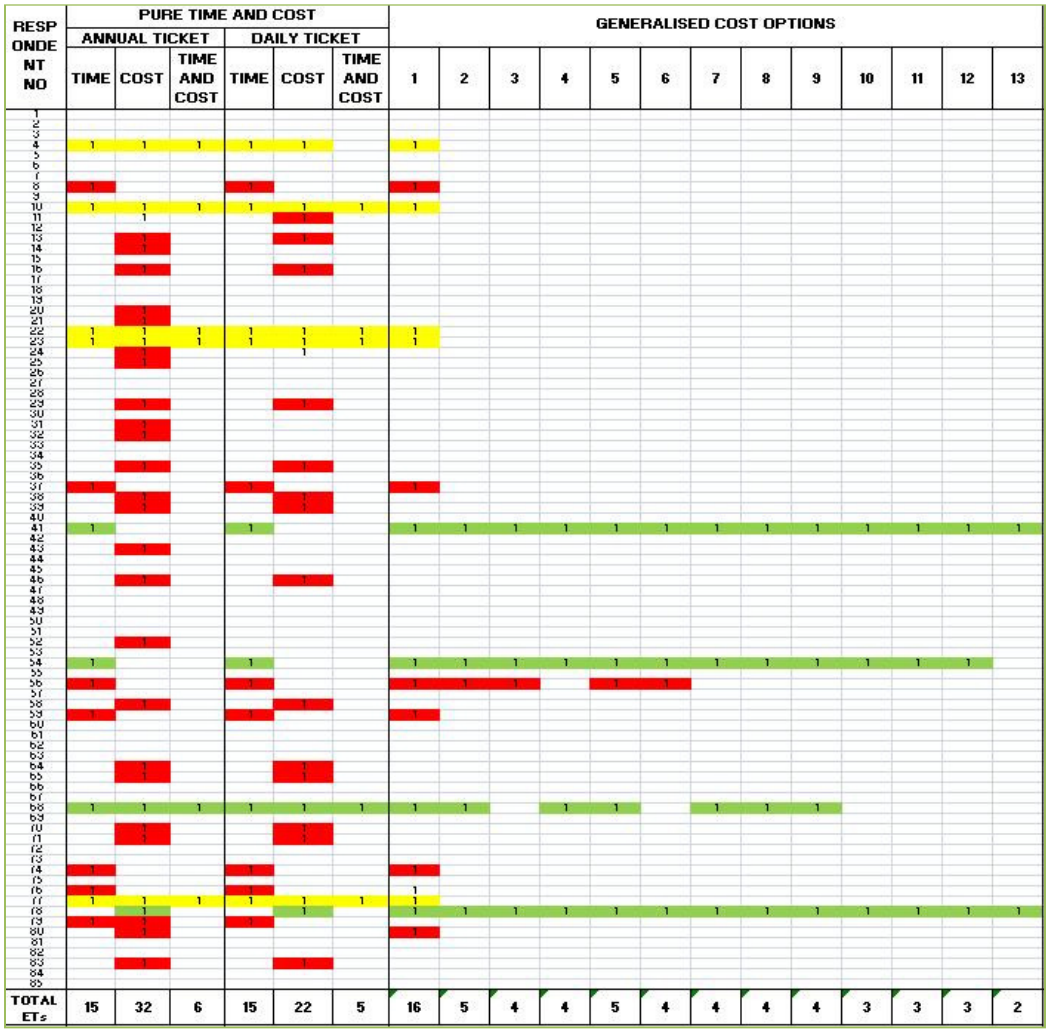

Table M.5 Identification of excess travellers using "pure time and cost" and "generalised cost" methods; pilot study. Source: This study. Key: yellow – ETs in each criteria, red – "time" ETs or "money" ETs, green – ETs common in both samples.

Question	Response options	ETs n=9	NETs n=59	Total n=65
Work Travel Frequency	a few days per week	2	23	25
	5 days per week	6	65	71
	every day	2	2	4
	work mainly at or from home	0	2	2
Work Travel Mode Usually Used	work mainly at or from home	0	2	2
	underground, metro, light rail	2	18	20
	train	0	2	2
	bus, minibus, coach	6	22	28
	driving a car or van	2	35	37
	passenger in a car or van	0	2	2

Table M.6 Travel to work frequency and modes usually used [%], pilot study, n=65. Source: This study.

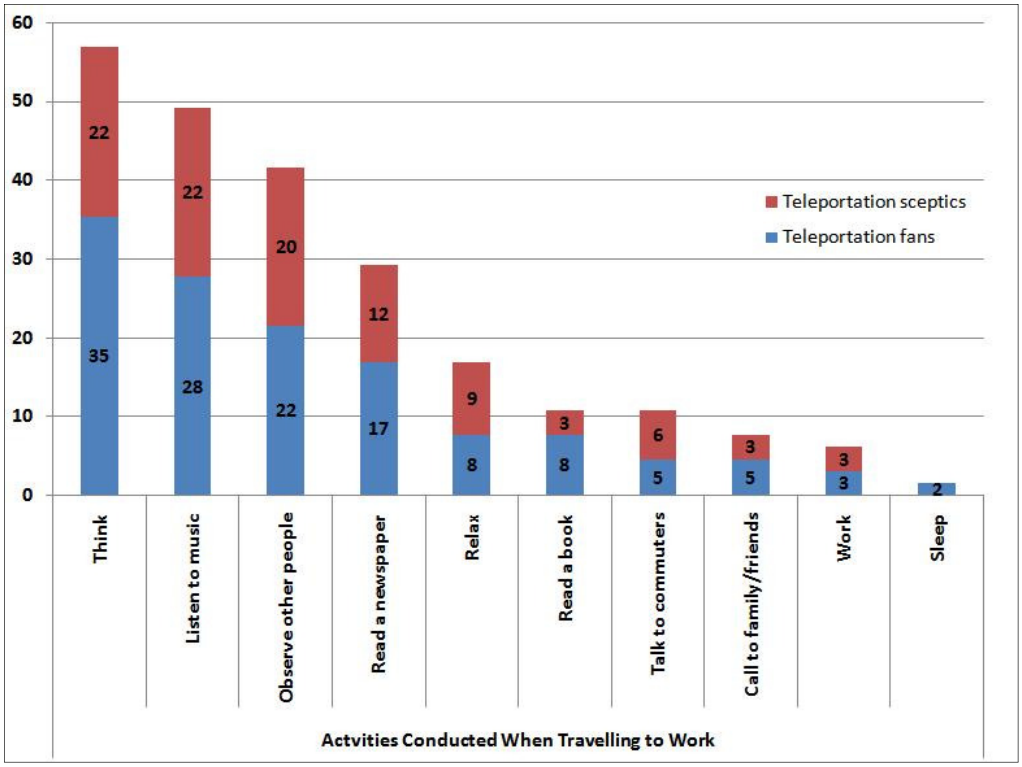

Figure M.1 Responses to multiple choice question 6 section 1 in the pilot study, "What do you do when you travel to work?" [total % of respondents who replied positively to the activity]; n=65.

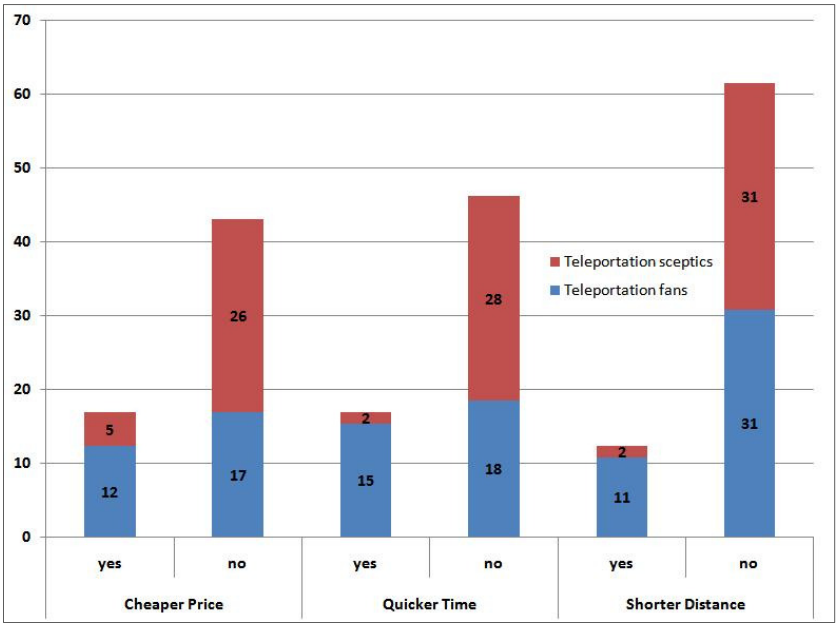

Figure M.2 Responses to multiple choice questions 7 and 11 in the pilot study, "What would encourage you to switch your transport mode to work?"; n=65.

Question	Response options	Teleportation Fans n=35	Teleportation Sceptics n=28
ETs definition	ET	8	6
	NET	46	37
Gender	Male	14	15
	Female	40	26
	No response	0	2
Marital Status	Single (never married)	18	12
	Married or re-married	29	26
	Separated or divorced	6	5
	Widowed	0	0
	No response	0	0
Number of People Living in Household	1 person	5	8
	2 people	23	15
	3 people	14	12
	4 people	9	6
	5 or more people	3	2
	No response	0	0
Driving License	Yes	46	31
	No	8	12
	No response	0	0
Number of Cars or vans in Household	None	5	8
	1 car	32	25
	2 cars	14	9
	3 cars	3	2
	4 cars or more	0	0
	No response	0	0
Commute time [mins]	<=10	3	5
	>10<=20	20	18
	>20<=30	11	11
	>30<=45	11	5
	>45<=60	3	3
	>60	5	2
Ideal one-way commute time [mins]	<=5	5	0
	>5<10	6	6
	>10<=15	23	8
	>15<=20	14	11
	>20<=30	3	15
	>30<=40	2	0
	>40<50	2	2

Table M.7 Socio-economic and travel characteristics of teleportation fans and sceptics [% of total sample], pilot study, n=65.

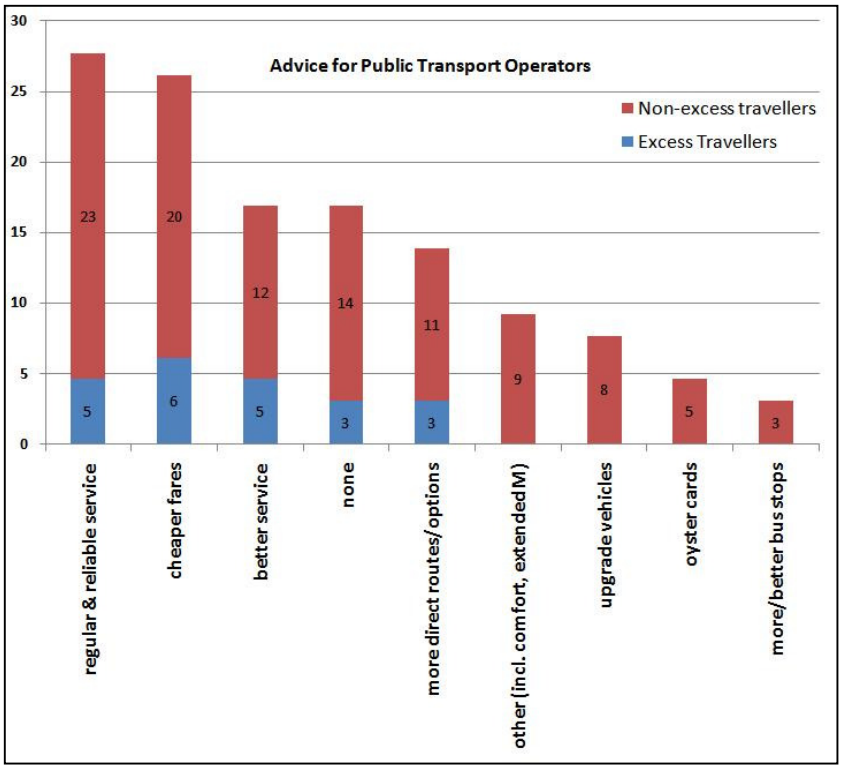

Figure M.3 Responses to multiple choice question 6 section 2 in the pilot study, "What could public transport operators do to encourage you to use local services more often instead of private car?" [total % of respondents who replied positively to the suggestion]; n=65.

No	Result Variable	Travel to work				Non-work travel			
		Mis-sing N	N of Valid Cases	Mean	Std. Dev.	Mis-sing N	N of Valid Cases	Mean	Std. Dev.
1	GOOD ACCESSIBILITY	2	85	3.90	1.511	2	85	3.99	1.225
2	GOOD COMFORT	3	85	3.54	1.249	2	85	3.86	1.231
3	CURIOSITY OF NEW PLACES	6	85	2.05	1.300	2	85	3.51	1.374
4	SHORT DISTANCE	3	85	3.56	1.343	3	85	2.89	1.440
5	HIGH INDEPENDENCE	2	85	3.86	1.251	2	85	4.00	1.148
6	LOW PRICE	2	85	3.77	1.364	3	85	3.84	1.222
7	GOOD SAFETY	1	85	4.14	1.204	2	85	4.23	1.162
8	SHORT TIME	2	85	4.19	1.076	3	85	3.38	1.411
9	GOOD ENJOYMENT	2	85	3.31	1.396	2	85	3.90	1.303

Table M.8 Descriptive statistics and missing sample responses for nine variables, pilot study, n=85.

Factors	Variables	Loadings
Factor 1: Enjoyment of travel	Good Enjoyment	.642
	Good Safety	.640
	Good Comfort	.600
	High Independence	.514
	Low Price	.464
	Good Accessibility	.363
Factor 2: Dimensions of travel	Short Distance	-.754
	Short Time	-.689
	Curiosity of New Places	.440
Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization. Rotation converged in 31 iterations.		

Table M.9 Factor loadings for nine variables.

No	Attitudes/preferences statements	Travel to work				Non-work travel			
		Mis-sing N	N of Valid Cases	Mean	St. Dev.	Mis-sing N	N of Valid Cases	Mean	St. Dev.
1	Sometimes I choose other route because I'm curious of the new route	2	85	1.57	.844	3	85	2.61	1.027
2	When I travel I have a chance to enjoy scenic beauty	3	85	1.99	1.036	4	85	2.86	1.009
3	A travel time is a good time to relax	3	85	2.44	.957	4	85	2.72	.939
4	A travel time is a good time to think	3	85	3.06	.851	4	85	3.00	.837
5	A travel time is a good time to clear my head	3	85	2.89	.903	5	85	2.95	.840
6	A travel time is a good way to be alone	3	85	2.63	.936	4	85	2.25	.929
7	I like to travel more just for the fun	3	85	1.51	.707	5	85	2.43	.978
8	For me longer travel is an escape	3	85	1.62	.855	4	85	2.37	1.030
9	I like to travel for travel's sake	4	85	1.40	.665	4	85	2.15	1.001
10	I like exploring new places	3	85	2.13	1.015	4	85	3.15	.950
11	Getting there is half the fun	4	85	1.73	.866	5	85	2.60	.989
12	My trip is a useful transition between home and work/destination	3	85	2.74	1.064	8	85	2.43	.979
13	I like travelling alone	5	85	2.63	.862	6	85	2.33	.930
14	I think my travel time is wasted	5	85	2.16	.947	8	85	1.78	.681
15	I think I could use my travel time more productively	5	85	2.14	1.028	9	85	1.76	.746
16	I think travel is boring	5	85	2.21	.924	8	85	1.83	.801
17	When I'm travelling every day is the same	4	85	2.62	.969	8	85	1.84	.708
18	The only good thing about travelling is arriving at your destination	4	85	2.47	1.013	9	85	2.03	.848
19	My trip is a real hassle	5	85	1.96	.849	9	85	1.75	.695
20	I am uncomfortable being around people I don't know when I travel	5	85	1.84	.961	9	85	1.91	.941
21	We need more public transportation, even if taxes have to pay for a lot of the costs	3	85	2.82	1.056	7	85	2.85	1.045

22	I think about climate change/other environmental issues when making travel choices	3	85	2.52	1.189	7	85	2.55	1.147
23	If I could find quicker and cheaper way I would use it	4	85	2.99	1.101	8	85	3.18	.942
24	I like to feel the sensation of speed when I'm driving	34	85	1.78	1.006	34	85	2.06	1.103
25	I feel proud of owning a vehicle	33	85	2.19	1.049	35	85	2.06	.998
26	I'm driving because there are more of us in a car	35	85	1.54	.706	36	85	2.20	.866
27	I enjoy driving because I've got a good car	33	85	1.98	.980	35	85	2.18	1.004

Table M.10 Descriptive statistics and missing sample responses for 27 statements, pilot sample, n=85.

Factors	**Variables**	**Loadings**
Factor 1: Enjoyment of travel	I like to travel more just for the fun	.894
	For me longer travel is an escape	.834
	I like to travel for travel's sake	.827
	I like exploring new places	.753
	Sometimes I choose other route because I'm curious of the new route	.723
	Getting there is half the fun	.696
	When I travel I have a chance to enjoy scenic beauty	.653
	I think about climate change/other environmental issues when making travel choices	.389
	We need more public transportation, even if taxes have to pay for a lot of the costs	.318
Factor 2: The negative side of travel	I think I could use my travel time more productively	.917
	I think my travel time is wasted	.781
	My trip is a real hassle	.529
	I think travel is boring	.424
	When I'm travelling every day is the same	.337
Factor 3: Travel as a transition	A travel time is a good way to be alone	.779
	A travel time is a good time to think	.601
	A travel time is a good time to clear my head	.583
	My trip is a useful transition between home and work/destination	.583
	I like travelling alone	.485
	A travel time is a good time to relax	.463
Factor 4: Discomfort of public travel	I am uncomfortable being around people I don't know when I travel	.516
Factor 5: Disutility of travel	If I could find quicker and cheaper way I would use it	-.457
	The only good thing about travelling is arriving at your destination	-.392
Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization. Rotation converged in 11 iterations.		

Table M.11 Factor loadings for 23 statements, pilot study.

Pilot questions	Type of travel	Factors	Mean values for Walkerville n=45	Mean values for the School of GPS[2] n=40
Travel options	Travel to Work	Enjoyment of travel	.060	-.485
		Dimensions of travel	-.343	-.424
	Non Work Travel	Enjoyment of travel	.413	-.047
		Dimensions of travel	.047	.757
Preferences related to travel perceptions	Travel to Work	Enjoyment of travel	-.688	-.405
		The negative side of travel	-.062	.461
		Travel as a transition	.214	.386
		Discomfort of public travel	.154	-.247
		Disutility of travel	.004	.152
	Non Work Travel	Enjoyment of travel	.285	.899
		The negative side of travel	-.241	-.125
		Travel as a transition	-.233	-.431
		Discomfort of public travel	-.027	.123
		Disutility of travel	-.065	-.215

Table M.12 Mean values of factors for two sub-samples; pilot sample, n=85.

Pilot questions	Type of travel	Factors	Excess Travellers (n=6)	Not Excess Travellers (n=59)
Travel options	Travel to work	Enjoyment of travel	.016	-.016
		Dimensions of travel	-.088	-.454
	Non-work travel	Enjoyment of travel	.162	.311
		Dimensions of travel	-.146	.413
Preferences related to travel perceptions	Travel to work	Enjoyment of travel	-.543	-.578
		The negative side of travel	.249	.167
		Travel as a transition	.034	.386
		Discomfort of public travel	.361	-.013
		Disutility of travel	-1.025	.040
	Non-work travel	Enjoyment of travel	.532	.632
		The negative side of travel	.307	-.192
		Travel as a transition	-.388	-.206
		Discomfort of public travel	-.720	.141
		Disutility of travel	-.934	-.077

Table M.13 Average values of factors for excess travellers and not excess travellers when using "pure time and cost" method; pilot study, n=65.

Type of travel	Factors	Option	Excess Travellers	Not Excess Travellers
Travel to work	Enjoyment of travel	1[3]	-.035	.006
		7[4]	-.709	.033
	Dimensions of travel	1	-.208	-.490
		7	-.040	-.445
Non-work travel	Enjoyment of travel	1	.373	.273
		7	.007	.316
	Dimensions of travel	1	.361	.361
		7	.735	.336

Table M.14 Mean values of factors related to travel options for excess travellers and not excess travellers when using "generalised cost" method with two different weight options; pilot study, n=65.

[2] School of Geography, Politics and Sociology

[3] for option 1: ETs n = 16, NETs n = 49.

[4] for option 7: ETs n = 4, NETs n = 61.

Type of travel	Factor	Options	Excess Travellers	Not Excess Travellers
Travel to work	Enjoyment of travel	1[12]	-.670	-.544
		7[13]	-.670	-.569
	The negative side of travel	1	.194	.169
		7	.427	.158
	Travel as a transition	1	.219	.397
		7	.557	.340
	Discomfort of public travel	1	-.090	.058
		7	-.479	.055
	Disutility of travel	1	-.504	.087
		7	.075	-.068
Non-work travel	Enjoyment of travel	1	.452	.679
		7	.560	.627
	The negative side of travel	1	-.078	-.167
		7	-.005	-.155
	Travel as a transition	1	-.294	-.199
		7	-.171	-.226
	Discomfort of public travel	1	-.193	.145
		7	-.170	.077
	Disutility of travel	1	-.442	-.063
		7	.476	-.198

Table M.15 Mean values of factors of preferences related to travel perceptions for excess travellers and not excess travellers when using "generalised cost" method (results for 2 out of 13 different weight options); pilot study, n=65.

Pilot questions	Type of travel	Factors	Excess Travellers (n=9)	Not Excess Travellers (n=56)
Travel options	Travel to work	Enjoyment of travel	-.156	.010
		Dimensions of travel	-.089	-.474
	Non-work travel	Enjoyment of travel	.256	.304
		Dimensions of travel	.146	.395
Preferences related to travel perceptions	Travel to work	Enjoyment of travel	-.721	-.552
		The negative side of travel	.332	.150
		Travel as a transition	.050	.402
		Discomfort of public travel	-.003	.026
		Disutility of travel	-.659	.038
	Non-work travel	Enjoyment of travel	.379	.662
		The negative side of travel	.140	-.192
		Travel as a transition	-.499	-.178
		Discomfort of public travel	-.624	.172
		Disutility of travel	-.410	-.115

Table M.16 Average values of factors for excess travellers and not excess travellers when using combined method; n=65.

Pilot questions	Type of travel	Factors	Mean for Excess Travellers	Mean for Not Excess Travellers	Sig.[5]	Sig.[6]	Sig.[7]
Travel options	Travel to work	Enjoyment of travel	-0.19	0.03	0.00	0.55	0.71
		Dimensions of travel	0.45	-0.07	0.04	0.15	0.04
	Non-work	Enjoyment of travel	-0.06	0.01	0.03	0.86	0.89
		Dimensions of travel	0.22	0.04	0.94	0.48	0.48
Preferences related to travel perceptions	Travel to work	Enjoyment of travel	-0.22	0.04	0.37	0.47	0.44
		The negative side of travel	0.14	-0.02	0.38	0.65	0.71
		Travel as a transition	-0.33	0.05	0.96	0.30	0.33
		Discomfort of public travel	-0.02	0.00	0.26	0.94	0.93
		Disutility of travel	-0.62	0.10	0.17	0.05	0.16
	Non-work travel	Enjoyment of travel	-0.27	0.04	0.17	0.38	0.51
		The negative side of travel	0.34	-0.06	0.62	0.27	0.36
		Travel as a transition	-0.32	0.05	0.42	0.30	0.38
		Discomfort of public travel	-0.72	0.12	0.27	0.02	0.06
		Disutility of travel	-0.24	0.04	0.18	0.44	0.57

Table M.17 ANOVA results for excess travellers and not excess travellers. Highlighted items significant at the 95% level

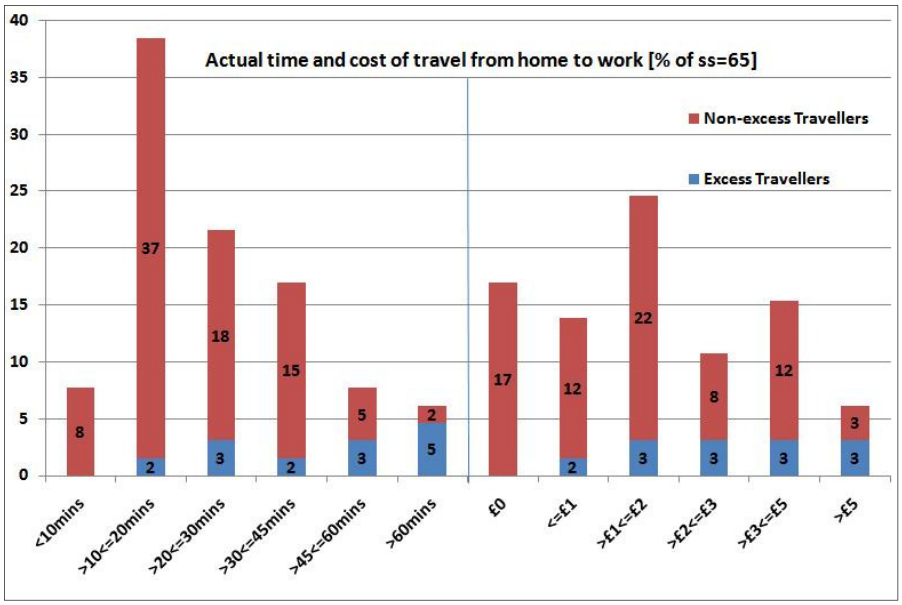

Figure M.4 Responses to question 5 section 1 in the pilot study, "What is your actual time and cost of your single journey from home to work?" [%]; n=65.

[5]Sig. from test of homogeneity of variances.

[6]Sig from ANOVA output.

[7]Sig. from tbust test of equality of means.

[in minutes]		Actual Time of Travel from Home to Work							
		<10	**>10 <=20**	**>20 <=30**	**>30 <=45**	**>45 <=60**	**>60**	**varies**	**No response**
Ideal One Way Commute Time	**<=5**	2	0	0	2	0	0	0	0
	>5<=10	6	3	0	0	0	0	0	0
	>10<=15	0	15	8	2	0	0	0	0
	>15<=20	0	11	3	2	0	0	0	2
	>20<=30	0	3	6	3	0	0	0	0
	>30<=40	0	0	0	0	0	0	0	0
	>40<50	0	0	0	0	2	0	0	0

Table M.18 Cross-tabulation of responses regarding actual vs. ideal one-way commute time. Selection of respondents who described the amount of their commute time as "about right" [% of 65 respondents]; pilot study, n=65.

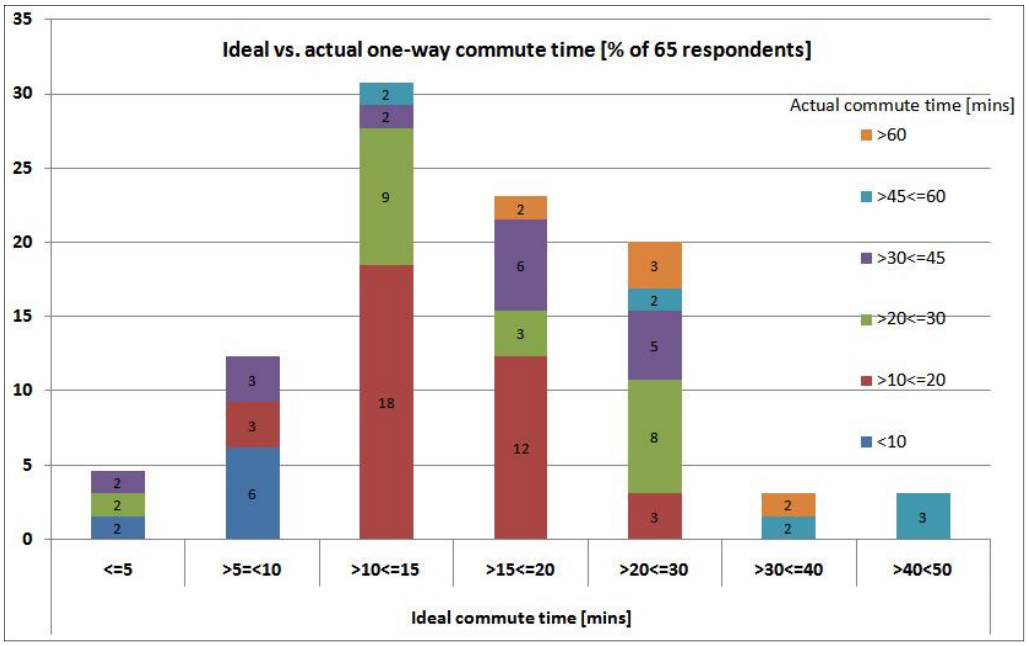

Figure M.5 Relationship between ideal and actual one-way commute time [%]; n=65.

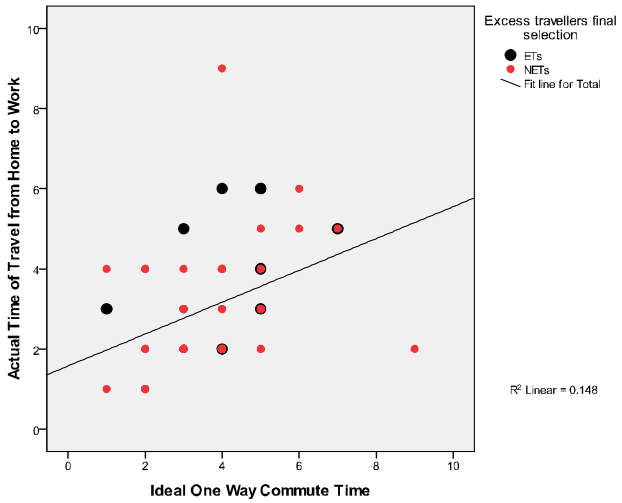

Figure M.6 Scatterplot showing a relationship between ideal-one way commute time and actual time of travel from home to work.

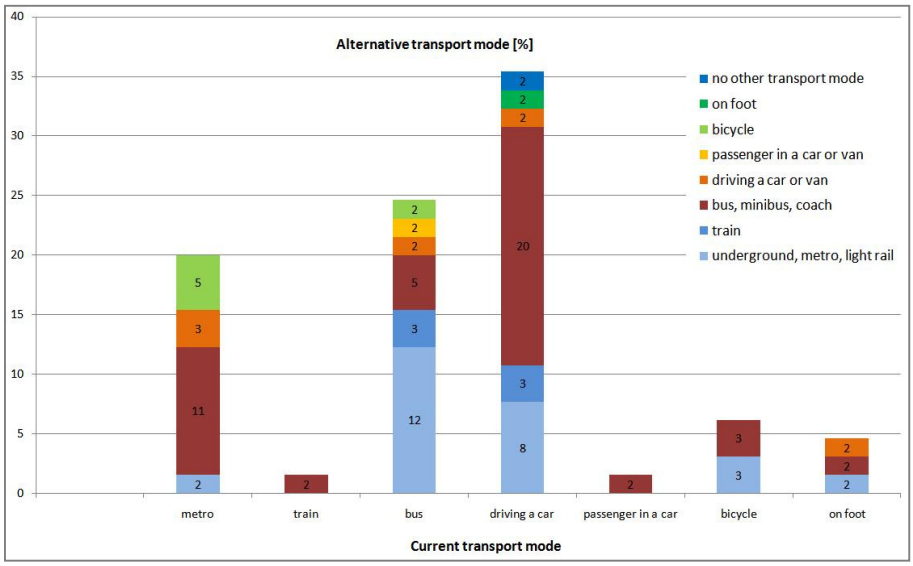

Figure M.7 Responses to questions 2 and 4 section 1 in the pilot study (about current and alternative transport modes for travel between home and work [%]; n=65).

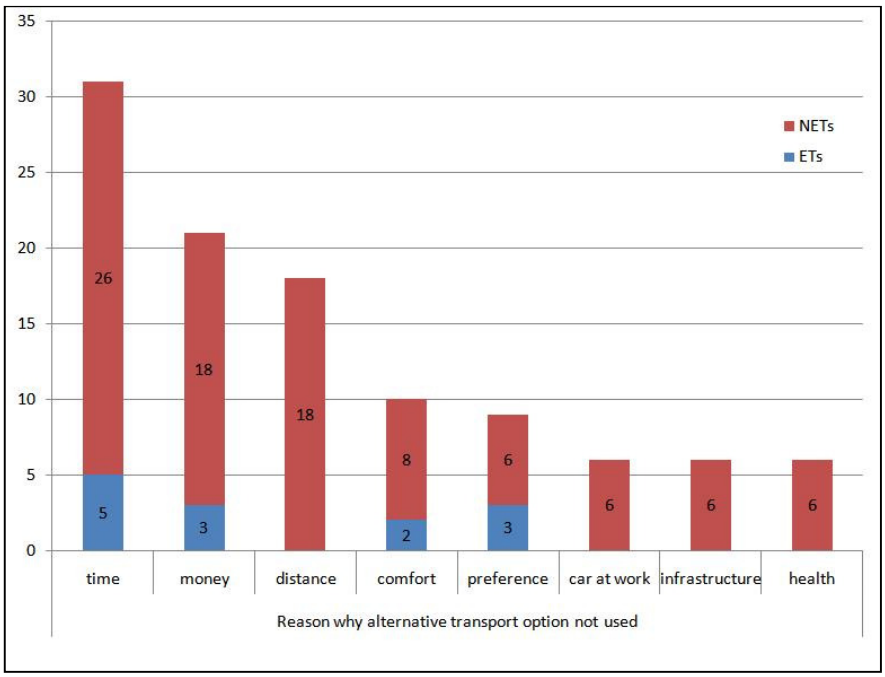

Figure M.8 Selected responses to open-ended question 4 section 1 in the pilot study (about alternative transport modes or options of travel to work and reason why these options are not used [%]; n=65).

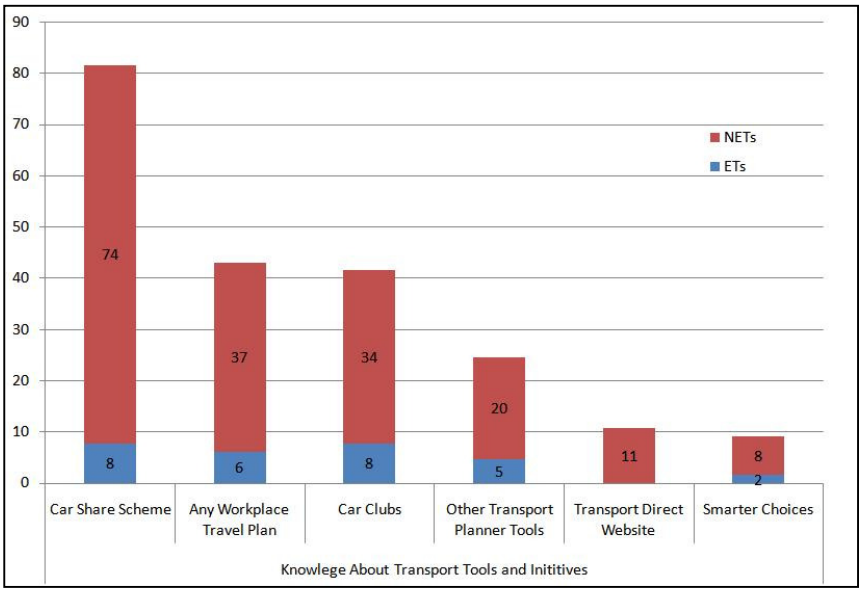

Figure M.9 Responses to question 12 section 2 about transport tools and initiatives [%]; pilot study, n=65.

Response options	Excess Travellers n=9	Not Excess Travellers n=59
Internet	5	55
Don't look	2	11
Newspapers/flyers/phonebook	3	3
Timetables	0	5
Ask people	0	2
Different places	0	2
Anywhere	0	2

Table M.19 Sources of information about local travel options [%]; pilot study, n=65.

		Opinion About a Level of Transport Infrastructure in the Area					Opinion About a Level of Transport Accessibility in the Area				
		very poor	poor	average	good	excellent	very poor	poor	average	good	excellent
Alternative transport option	work mainly at or from home	0	0	0	0	0	0	0	0	0	0
	underground, metro, light rail	2	2	11	9	3	0	2	9	11	5
	train	0	2	0	5	0	2	2	2	2	0
	bus, minibus, coach	0	6	15	18	5	0	2	17	18	8
	motorcycle, scooter or moped	0	0	0	0	0	0	0	0	0	0
	driving a car or van	0	2	2	5	0	0	0	3	5	0
	passenger in a car or van	0	0	0	2	0	0	0	0	2	0
	taxi or minicab	0	0	0	0	0	0	0	0	0	0
	no response	0	0	3	0	0	0	0	3	0	0
	bicycle	0	0	2	3	2	0	0	0	0	6
	on foot	0	0	0	2	0	0	0	0	2	0
	other	0	0	0	2	0	0	0	0	0	2
	no other transport mode	0	0	0	2	0	0	0	0	2	0
Total %		2	12	33	48	10	2	6	34	42	21

Table M.20 Alternative transport options vs. opinions about transport infrastructure and accessibility [%]; n=65.

Importance of factors when choosing travel to work	Not Excess Travellers (n=56)	Excess Travellers (n=9)	p-value (2 tailed) for difference of means
good accessibility	4.13	4.67	.079
good comfort	3.55	3.78	.582
curiosity of new places	1.89	3.00	.073
short distance	3.70	3.00	.142
high independence	4.00	3.89	.809
low price	4.00	3.78	.677
good safety	4.41	3.89	.320
short time	4.33	4.00	.319
good enjoyment	3.55	3.00	.237

Table M.21 Attitudes towards factors influencing travel to work options and mean values (scale: 1 - not important, 5 - very important); n=65.

Statement	Not Excess Travellers (n=56)	Excess Travellers (n=9)	p-value (2 tailed) for difference of means
Sometimes I choose other route because I'm curious of the new route	1.54	1.67	.678
When I travel I have a chance to enjoy scenic beauty	1.91	1.78	.738
A travel time is a good time to relax	2.52	1.78	.032
A travel time is a good time to think	3.13	3.22	.697
A travel time is a good time to clear my head	2.95	3.00	.865
A travel time is a good way to be alone	2.75	2.56	.551
I like to travel more just for the fun	1.57	1.33	.232
For me longer travel is an escape	1.66	1.44	.556
I like to travel for travel's sake	1.43	1.00	.040
I like exploring new places	2.16	2.11	.897
Getting there is half the fun	1.68	1.56	.653
My trip is a useful transition between home and work/destination	2.79	2.44	.451
I like travelling alone	2.51	2.56	.900
I think my travel time is wasted	2.11	2.56	.187
I think I could use my travel time more productively	2.13	2.11	.974
I think travel is boring	2.21	2.67	.231
When I'm travelling every day is the same	2.68	2.44	.530
The only good thing about travelling is arriving at your destination	2.57	2.44	.757
My trip is a real hassle	1.86	2.44	.128
I am uncomfortable being around people I don't know when I travel	1.89	1.56	.244
We need more public transportation, even if taxes have to pay for a lot of the costs	2.75	3.22	.154
I think about climate change/other environmental issues when making travel choices	2.66	1.78	.015
If I could find quicker and cheaper way I would use it	3.00	3.50	.126

Table M.22 Statements characterising travel to work and mean values (scale: 1 – not at all true, 2 – not very true, 3 – fairly true, 4 – very true); pilot study, n=65. Highlighted items significant at the 95% level

APPENDIX N

Some characteristics of the five LSOAs selected

First LSOA: Hyde Park

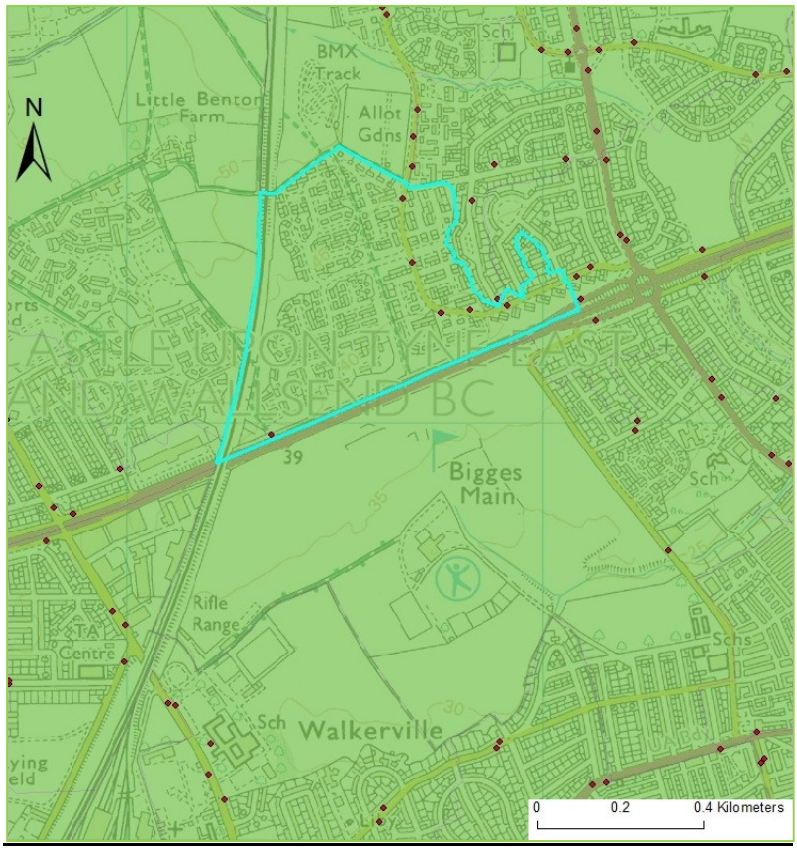

Figure N.1 Hyde Park Lower Super Output Area. Source: UK Borders and Digimap

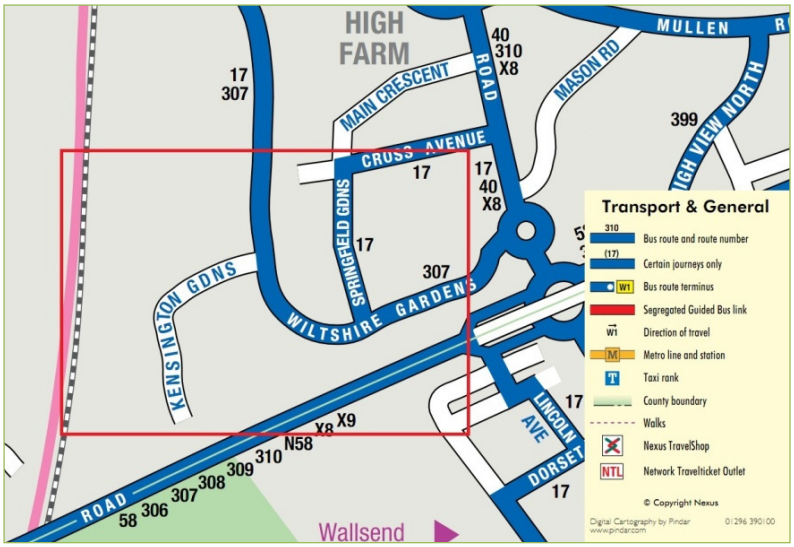

Figure N.2 Public transport links within red area in Hyde Park. Source: Guide to bus services in the North Tyneside area from www.nexus.org.uk

Second LSOA: Battle Hill Drive

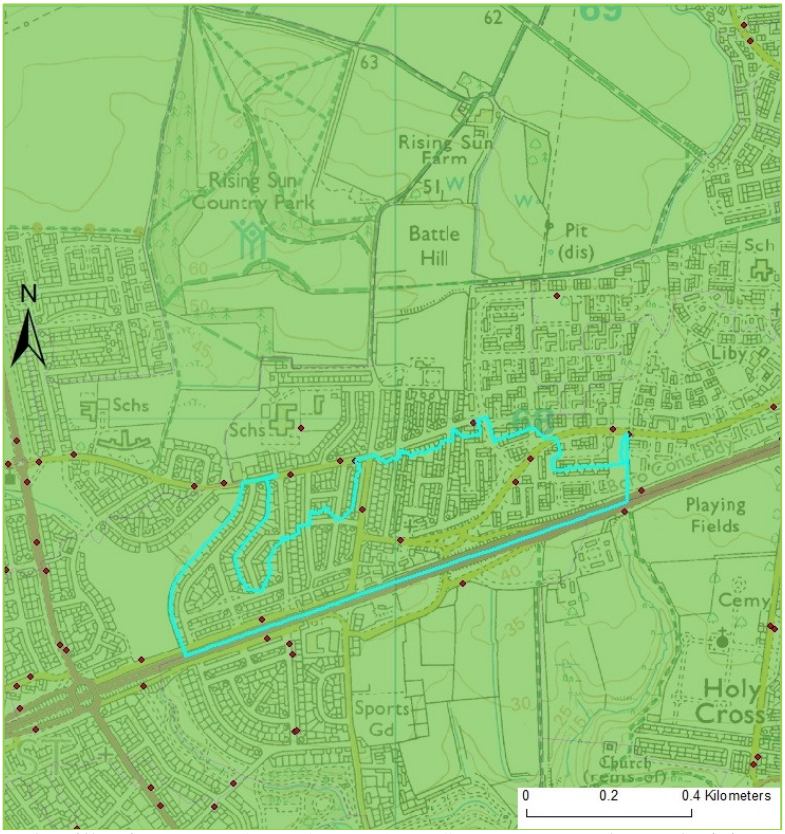

Figure N.3 Battle Hill Drive Lower Super Output Area. Source: UK Borders and Digimap

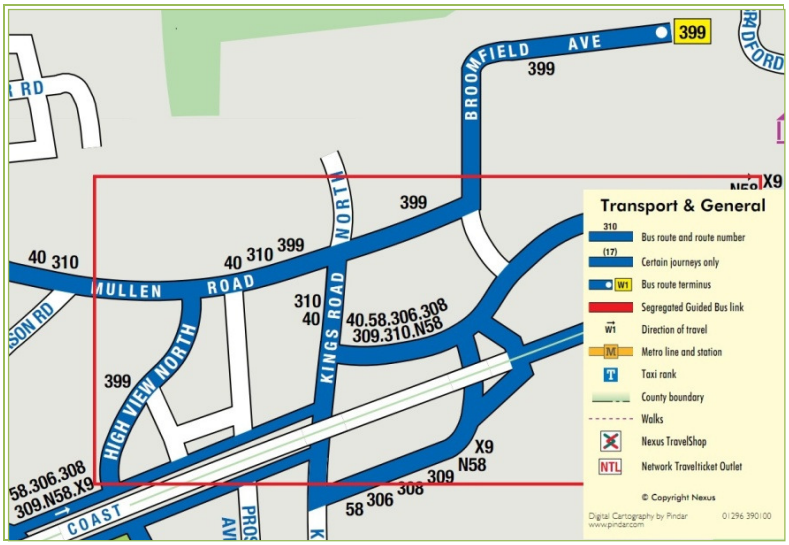

Figure N.4 Public transport links within red area in Battle Hill Drive. Source: Guide to bus services in the North Tyneside area from www.nexus.org.uk

Third LSOA: Warkworth Avenue

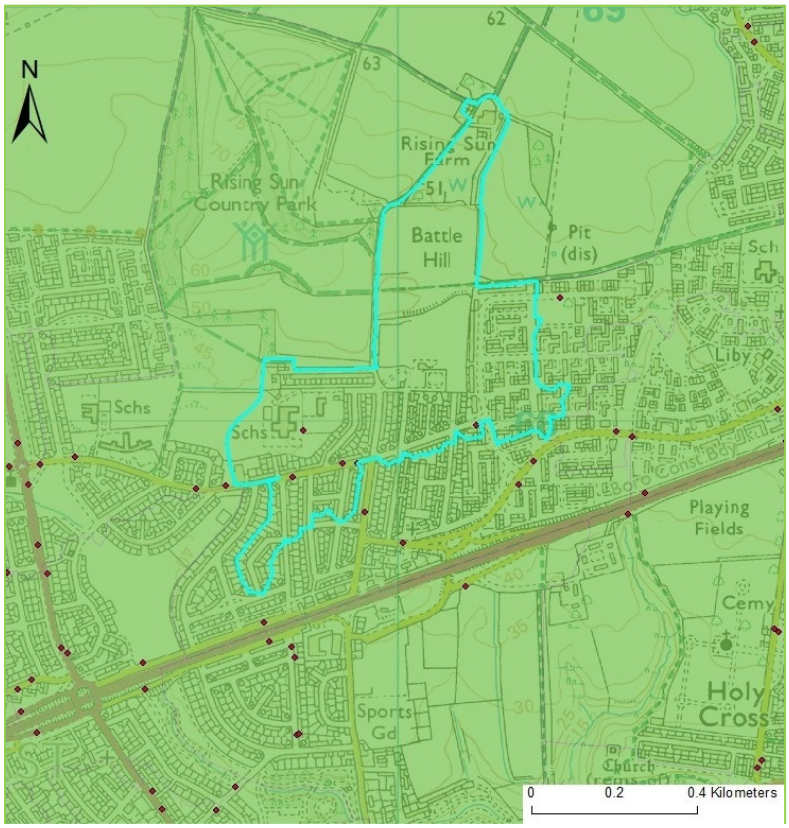

Figure N.5 Warkworth Avenue Lower Super Output Area. Source: UK Borders and Digimap

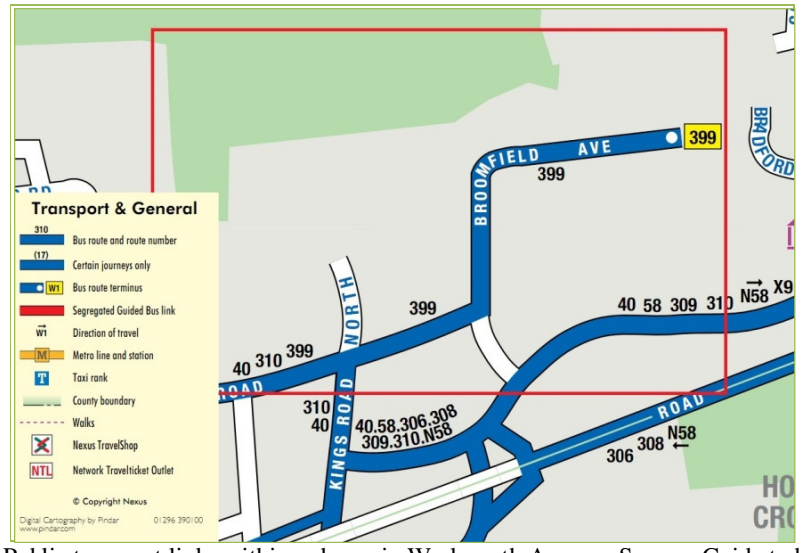

Figure N.6 Public transport links within red area in Warkworth Avenue. Source: Guide to bus services in the North Tyneside area from www.nexus.org.uk

Fourth LSOA: Hadrian Park

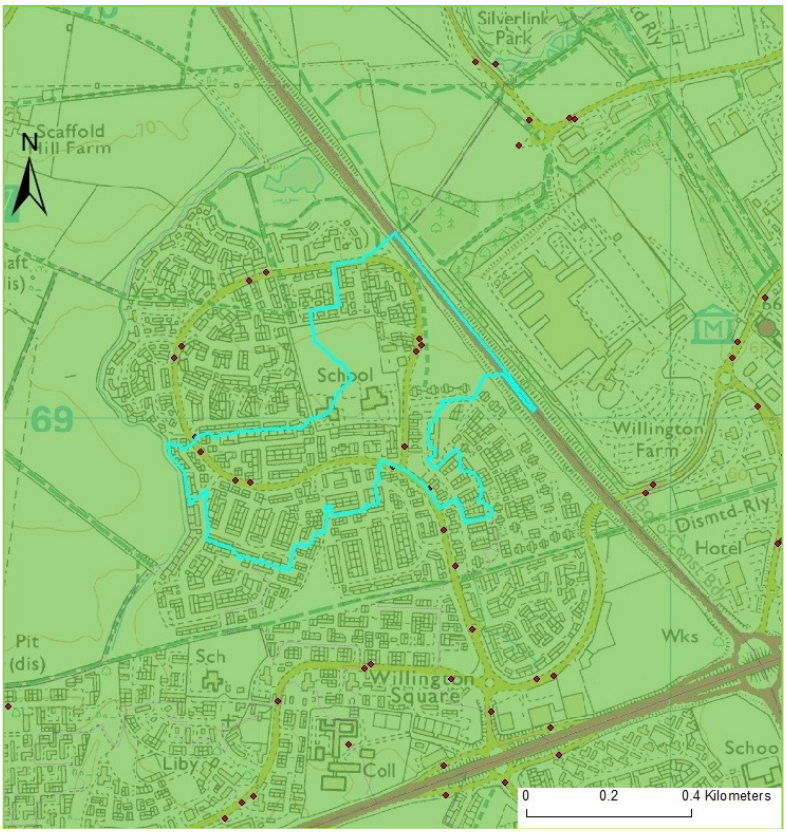

Figure N.7 Hadrian Park Lower Super Output Area. Source: UK Borders and Digimap

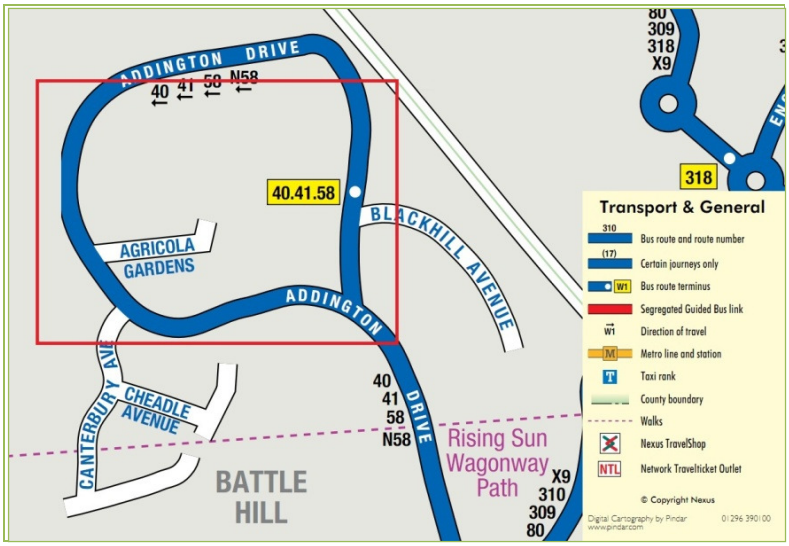

Figure N.8 Public transport links within red area in Hadrian Park. Source: Guide to bus services in the North Tyneside area from www.nexus.org.uk

Fifth LSOA: Fulwell

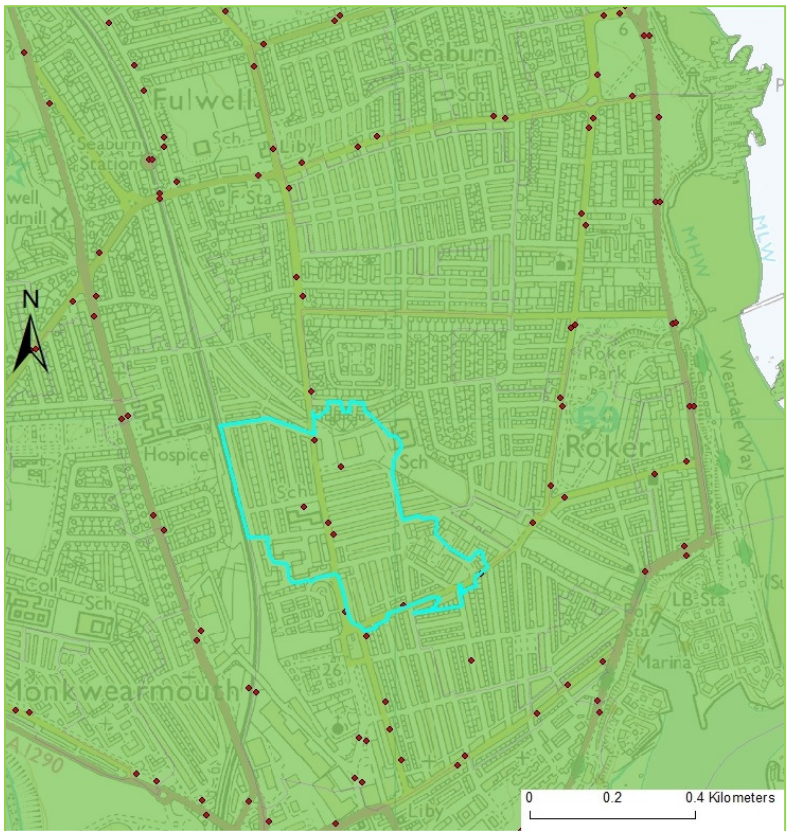

Figure N.9 Fulwell Lower Super Output Area. Source: UK Borders and Digimap

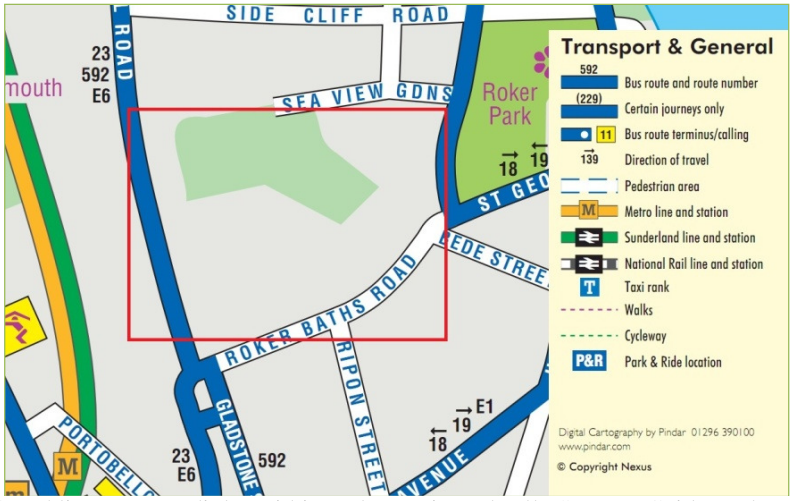

Figure N.10 Public transport links within red area in Fulwell. Source: Guide to bus services in Sunderland area from www.nexus.org.uk

Appendix O

Additional results for the main study

Cate-gory	Options		Total sample n=223	Time		Cost		Effort		Generalised cost	
				NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Gender	Male		41	42	40	43	35	37	42	44	37
	Female		59	58	59	56	65	63	57	56	62
	No response		0	0	1	1	0	0	1	0	1
	Pearson Chi-square		-	0.839		1.914		0.755		2.201	
	p-value		-	0.657		0.384		0.685		0.333	
Age	23 or younger		3	2	4	3	4	0	4	2	5
	24-40		40	44	38	38	45	39	41	41	39
	41-64		54	51	56	56	49	55	53	54	53
	65-74		2	3	2	3	1	6	1	2	2
	No response		0	0	1	1	0	0	1	0	1
	Pearson Chi-square		-	2.768		2.149		6.528		3.383	
	p-value		-	0.597		0.708		0.163		0.496	
Marital Status	Single		32	42	25	32	34	35	32	37	27
	Married		53	44	60	49	62	51	53	50	57
	Separated		12	12	12	16	3	10	13	11	14
	Widowed		2	2	2	3	1	4	2	3	1
	No response		0	0	1	1	0	0	1	0	1
	Pearson Chi-square		-	8.455		9.905		1.573		5.155	
	p-value		-	0.076		0.042		0.814		0.272	
Number of People Living in Household	1 person		18	19	17	21	11	20	17	21	14
	2 people		33	35	32	33	34	41	31	33	33
	3 people		27	22	30	25	31	22	28	24	30
	4 people		17	16	18	16	21	14	18	15	20
	5 or more people		4	7	2	5	3	2	5	6	2
	No response		0	0	1	1	0	0	1	0	1
	Pearson Chi-square		-	6.717		4.879		3.049		5.959	
	p-value		-	0.243		0.431		0.692		0.310	
Reason why Moved into the Area	Nice area		26	24	28	28	24	18	29	24	30
	Work/university		5	6	4	6	3	8	4	6	4
	Better house		24	21	26	24	24	29	22	24	23
	Family/partner		13	18	10	11	18	18	12	16	10
	Personal		11	12	10	13	8	10	11	12	10
	Never moved		9	11	8	8	13	6	10	10	9
	Other		9	4	12	8	10	6	9	6	12
	No response		2	2	2	3	0	4	2	2	2
	Pearson Chi-square		-	9.146		7.459		6.772		5.726	
	p-value		-	0.242		0.383		0.453		0.572	
Place from Where Moved into the Area	Elsewhere in the NE		55	61	50	57	51	63	53	59	51
	Elsewhere in the UK		4	2	6	3	6	0	5	3	5
	Elsewhere abroad		4	6	2	3	6	4	4	6	2
	No response		37	31	42	36	38	33	38	33	42
	Pearson Chi-square		-	6.581		1.737		3.573		4.195	
	p-value		-	0.087		0.629		0.311		0.241	
Economic Activity	Higher Managerial and Professional	PT	1	0	2	0	4	0	2	0	3
		FT	14	13	14	14	14	6	16	15	13
		SE	0	1	0	0	1	0	1	1	0
	Lower Managerial and Professional	PT	2	0	4	1	4	0	3	1	4
		FT	38	41	36	39	35	39	38	37	39
	Supervisor,	PT	2	2	2	2	3	4	2	2	2
		FT	11	12	10	10	14	12	11	12	10

production	SE	4	3	5	5	3	4	4	3	5
Clerical, retail staff	PT	11	10	11	13	7	18	9	11	11
	FT	7	8	6	7	7	4	7	8	5
Student	FT	0	0	1	1	0	0	1	0	1
Other	PT	2	2	2	2	1	6	1	2	1
	FT	5	7	4	6	4	4	6	7	3
	SE	0	0	1	0	1	0	1	0	1
No response		1	0	2	1	0	2	1	0	2
Pearson Chi-square		-	13.334		17.170		18.548		16.127	
p-value		-	0.500		0.247		0.183		0.306	

Table O.1 Socio-economic characteristics of EC and NEC within the four samples. PT – part-time; FT – full-time; SE – self-employed. Highlighted significant at the 95% level, Pearson Chi-square test used.

Variable	**Kolmogorov-Smirnov test**			**Shapiro-Wilk test**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Good Accessibility	0.328	217	0	0.702	217	0
Good Comfort	0.216	217	0	0.852	217	0
Curiosity of New Places	0.268	217	0	0.804	217	0
High Independence	0.234	217	0	0.828	217	0
Low Price	0.261	217	0	0.771	217	0
Good Safety	0.293	217	0	0.733	217	0
Short Time	0.303	217	0	0.729	217	0
Good Enjoyment	0.200	217	0	0.874	217	0
Good Health	0.175	217	0	0.885	217	0
Environment	0.193	217	0	0.881	217	0
a Lilliefors Significance Correction						

Table O.2 SPSS output of the normality test K-S for eleven variables related to commute

Statement	Kolmogorov-Smirnov test			Shapiro-Wilk test		
	Statistic	df	Sig.	Statistic	df	Sig.
Sometimes I choose other route because I am curious of the new route	0.241	145	0	0.821	145	0
When I travel I have a chance to enjoy scenic beauty	0.238	145	0	0.82	145	0
A travel time is a good time to relax	0.214	145	0	0.856	145	0
A travel time is a good time to think	0.286	145	0	0.85	145	0
A travel time is a good time to clear my head	0.221	145	0	0.87	145	0
A travel time is a good way to be alone	0.259	145	0	0.839	145	0
I like to travel more just for the fun	0.269	145	0	0.805	145	0
For me longer travel is an escape	0.210	145	0	0.873	145	0
I like to travel for travel's sake	0.214	145	0	0.862	145	0
I like exploring new places	0.230	145	0	0.845	145	0
Getting there is half the fun	0.217	145	0	0.843	145	0
My trip is a useful transition between home and work/destination	0.210	145	0	0.875	145	0
I like travelling alone	0.246	145	0	0.871	145	0
I think my travel time is wasted	0.345	145	0	0.803	145	0
I think I could use my time more productively	0.297	145	0	0.846	145	0
I think travel is boring	0.287	145	0	0.853	145	0
When I am travelling every day is the same	0.218	145	0	0.878	145	0
The only good think about travelling is arriving at your destination	0.200	145	0	0.876	145	0
My trip is a real hassle	0.237	145	0	0.812	145	0
I am uncomfortable being around people I don't know when I travel	0.242	145	0	0.856	145	0
We need more public transportation, even if taxes have to pay for a lot of the costs	0.213	145	0	0.88	145	0
I think about climate change/other environmental issues when making travel choices	0.240	145	0	0.873	145	0
If I could find quicker and cheaper way I would use it	0.249	145	0	0.861	145	0
I like to feel the sensation of speed when I am driving	0.212	145	0	0.852	145	0
Driving a car gives me a feeling of pride in myself	0.237	145	0	0.849	145	0
I am driving because there are more of us in a car	0.314	145	0	0.765	145	0
I enjoy driving because I have got a good car	0.208	145	0	0.849	145	0
a Lilliefors Significance Correction						

Table O.3 SPSS output of the test of normality K-S for 27 statements describing commuting

Statement	Group	Time			Cost			Effort			Generalised cost		
		Mean	Std. dev.	Asymp. Sig. (2-tailed)	Mean	Std. dev	Asymp. Sig. (2-tailed)	Mean	Std. dev.	Asymp. Sig. (2-tailed)	Mean	Std. dev	Asymp. Sig. (2-tailed)
Sometimes I choose other route because I am curious of the new route	NEC	1.80	0.939	0.091	1.66	0.780	0.000	2.09	0.868	0.436	1.81	0.873	0.148
	EC	1.88	0.731		2.22	0.737		1.81	0.793		1.89	0.746	
When I travel I have a chance to enjoy scenic beauty	NEC	1.80	0.849	0.778	1.76	0.834	0.002	2.14	0.834	0.131	1.80	0.827	0.668
	EC	1.98	0.816		2.22	0.737		1.88	0.826		2.03	0.822	
A travel time is a good time to relax	NEC	2.12	0.909	0.379	2.02	0.838	0.020	2.27	0.883	0.610	2.03	0.884	0.102
	EC	2.20	0.862		2.46	0.885		2.15	0.878		2.31	0.854	
A travel time is a good time to think	NEC	2.61	0.940	0.406	2.41	0.984	0.112	2.55	1.057	0.353	2.49	0.974	0.978
	EC	2.46	0.935		2.70	0.814		2.50	0.918		2.53	0.905	
A travel time is a good time to clear my head	NEC	2.31	0.969	0.473	2.07	0.914	0.023	2.23	0.922	0.589	2.19	0.921	0.851
	EC	2.16	0.871		2.48	0.839		2.21	0.908		2.24	0.898	
A travel time is a good way to be alone	NEC	2.22	1.026	0.857	1.99	0.995	0.178	2.18	0.958	0.056	2.10	0.965	0.989
	EC	1.96	0.867		2.16	0.792		2.02	0.927		2.00	0.900	
I like to travel more just for the fun	NEC	1.92	0.913	0.845	1.69	0.813	0.109	1.82	0.907	0.725	1.84	0.911	0.729
	EC	1.73	0.806		2.00	0.881		1.80	0.839		1.76	0.786	
For me longer travel is an escape	NEC	2.43	1.082	0.536	2.23	1.026	0.102	2.50	1.102	0.446	2.46	1.073	0.506
	EC	2.35	0.947		2.66	0.872		2.36	0.976		2.31	0.915	
I like to travel for travel's sake	NEC	2.14	0.980	0.996	2.03	0.973	0.133	2.14	0.941	0.851	2.20	1.016	0.687
	EC	2.14	0.911		2.34	0.823		2.14	0.935		2.08	0.850	
I like exploring new places	NEC	2.73	1.185	0.993	2.49	1.09	0.000	2.73	1.202	0.663	2.74	1.200	0.926
	EC	2.78	1.028		3.26	0.876		2.76	1.064		2.77	0.967	
Getting there is half the fun	NEC	2.16	0.903	0.127	2.08	0.907	0.078	1.95	0.999	0.352	2.16	0.958	0.151
	EC	1.97	0.909		1.94	0.913		2.05	0.895		1.92	0.850	
My trip is a useful transition between home and work/destination	NEC	2.69	1.068	0.460	2.46	1.029	0.338	2.73	1.032	0.608	2.67	1.086	0.220
	EC	2.35	0.970		2.48	0.995		2.42	1.008		2.28	0.909	
I like travelling alone	NEC	2.65	0.976	0.871	2.65	0.998	0.155	2.95	0.785	0.180	2.63	0.951	0.871
	EC	2.61	0.964		2.56	0.907		2.56	0.985		2.61	0.985	
I think my travel time is wasted	NEC	2.57	0.985	0.474	2.68	0.902	0.276	2.32	0.945	0.344	2.66	0.991	0.643
	EC	2.83	0.757		2.84	0.738		2.81	0.813		2.81	0.692	
I think I could use my time more productively	NEC	2.35	0.934	0.125	2.51	0.921	0.630	2.50	0.964	0.749	2.53	0.959	0.776
	EC	2.67	0.847		2.66	0.823		2.57	0.879		2.59	0.824	
I think travel is boring	NEC	2.39	0.918	0.574	2.55	0.872	0.509	2.32	0.780	0.312	2.49	0.928	0.647
	EC	2.63	0.829		2.54	0.862		2.59	0.877		2.60	0.805	
When I am travelling every day is the same	NEC	2.41	0.942	0.186	2.54	0.976	0.003	2.23	0.922	0.901	2.44	0.942	0.240
	EC	2.36	0.982		2.08	0.877		2.41	0.974		2.32	0.989	

The only good think about travelling is arriving at your destination	NEC	2.27	0.961	0.545	2.45	1.019	0.024	2.18	0.795	0.825	2.43	1.015	0.281
	EC	2.40	1.009		2.18	0.919		2.39	1.021		2.29	0.969	
My trip is a real hassle	NEC	1.75	0.977	0.197	2.04	1.01	0.041	1.77	0.752	0.892	1.94	1.020	0.912
	EC	2.03	0.944		1.72	0.834		1.96	0.995		1.92	0.912	
I am uncomfortable being around people I don't know when I travel	NEC	2.55	1.083	0.528	2.71	1.071	0.290	2.68	1.129	0.311	2.69	1.110	0.764
	EC	2.71	1.043		2.56	1.033		2.65	1.048		2.63	1.010	
We need more public transportation, even if taxes have to pay for a lot of the costs	NEC	2.39	0.940	0.882	2.68	0.902	0.000	2.55	0.739	0.457	2.43	0.941	0.899
	EC	2.59	0.932		2.20	0.926		2.51	0.970		2.60	0.930	
I think about climate change/other environmental issues when making travel	NEC	2.53	0.987	0.601	2.51	0.955	0.424	2.50	0.964	0.915	2.53	1.003	0.883
	EC	2.44	0.899		2.40	0.881		2.46	0.926		2.41	0.856	
If I could find quicker and cheaper way I would use it	NEC	3.00	0.938	0.022	2.84	0.949	0.739	2.64	0.953	0.671	2.96	0.939	0.012
	EC	2.73	0.918		2.80	0.904		2.86	0.926		2.71	0.912	
I like to feel the sensation of speed when I am driving	NEC	2.00	0.980	0.328	2.12	0.861	0.114	1.64	0.902	0.017	1.96	0.924	0.110
	EC	2.07	0.820		1.92	0.900		2.12	0.855		2.13	0.827	
Driving a car gives me a feeling of pride in myself	NEC	1.86	0.917	0.083	1.96	0.849	0.308	1.50	0.598	0.005	1.89	0.877	0.063
	EC	2.12	0.853		2.16	0.934		2.12	0.892		2.16	0.871	
I am driving because there are more of us in a car	NEC	1.47	0.644	0.053	1.58	0.738	0.206	1.59	0.666	0.869	1.56	0.754	0.122
	EC	1.74	0.802		1.78	0.790		1.66	0.777		1.73	0.759	
I enjoy driving because I have got a good car	NEC	1.92	0.977	0.132	2.04	0.910	0.933	1.82	0.958	0.147	1.93	0.922	0.082
	EC	2.13	0.870		2.08	0.922		2.10	0.900		2.17	0.891	

Table O.4 Comparison of means for NEC and EC within the four groups for 27 statements characterising commuting. 4-point scale from 1- not at all true to 4 – very true. Highlighted items significant at the 95% level

Activities Conducted When Travelling to Work	Total sample n=223	Time				Cost				Effort				Generalised cost			
		NEC n=98	EC n=125	Chi-square	p-value	NEC n=152	EC n=71	Chi-square	p-value	NEC n=49	EC n=174	Chi-square	p-value	NEC n=123	EC n=100	Chi-square	p-value
Sleep	2	1	2	0.594	.441a	1	3	0.619	.431a	0	2	1.147	.284a,b	1	3	1.498	.221a
Think	56	55	56	0.018	0.893	53	62	1.710	0.191	55	56	0.006	0.936	54	58	0.421	0.516
Listen to music/radio	58	61	56	0.617	0.432	53	70	6.301	.012*	49	61	2.242	0.134	59	57	0.125	0.723
Read books	20	27	15	4.378	.036*	18	25	1.730	0.188	31	17	4.244	.039*	22	18	0.535	0.465
Read newspapers	23	26	21	0.691	0.406	19	31	3.890	.049*	37	19	6.844	.009*	23	23	0.002	0.967
Talk	18	21	15	1.448	0.229	17	20	0.224	0.636	27	16	3.151	0.076	20	16	0.462	0.497
Call	7	8	6	0.575	0.448	7	6	0.198	.656a	8	6	0.207	.649a	7	7	0.022	0.883
Work	4	4	3	0.123	.725a	2	7	3.595	.058a	6	3	1.167	.280a	4	3	0.181	.671a
Relax	18	16	19	0.308	0.579	19	15	0.423	0.516	20	17	0.26	0.61	18	18	0.000	0.982
Observe other people	36	36	36	0.002	0.965	35	38	0.210	0.647	39	35	0.23	0.632	35	37	0.100	0.752
Observe the area	35	37	34	0.131	0.718	34	38	0.308	0.579	39	34	0.308	0.579	38	32	0.930	0.335
Switch on/off for work	26	27	26	0.025	0.875	29	20	2.142	0.143	20	28	1.024	0.312	30	21	2.364	0.124
Exercise	20	17	22	0.627	0.428	26	6	13.07	.000*	8	23	5.306	.021*	21	18	0.343	0.558
Concentrate on the road	50	40	58	7.605	.006*	49	54	0.453	0.501	27	57	14.102	.000*	45	57	3.330	0.068
Other	3	2	3	0.282	.595a	1	7	7.534	.006a,*	4	2	0.464	.496a	2	4	1.187	.276a

Results are based on nonempty rows and columns in each innermost subtable. . More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid. b. The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid. *. The Chi-square statistic is significant at the 0.05 level.

Table O.5 Percentage of respondents within groups conducting various activities while commuting (multiple choice) [%]. Highlighted items significant at the 95% level. Pearson Chi-square test used.

Same transport route every time	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
No	26	22	28	25	27	20	27	24	28
Yes	74	78	72	75	73	80	73	76	72
Pearson Chi-square	-	.890		0.79		.876		.567	
Asymp. .sig (2-sided)	-	0.346		0.779		0.349		0.451	

Table O.6 Percentage of respondents within groups using same transport route every time [%]. Pearson Chi-square test used.

Same transport mode every time	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
No	30	32	30	30	31	25	32	31	30
Yes	61	59	61	61	59	63	60	59	62
No response	9	9	9	9	10	12	8	10	8
Pearson Chi-square	-	.136		.133		1.571		.268	
Asymp. .sig (2-sided)	-	0.934		0.936		0.456		0.875	

Table O.7 Percentage of respondents within groups using same transport mode every time [%]. Pearson Chi-square test used.

Same Transport Route Every Time	Non-car commuters								Commuters by car							
	Time		Cost		Effort		Generalised cost		Time		Cost		Effort		Generalised cost	
	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC
No	12	9	10	11	14	9	11	9	10	19	15	15	6	18	12	19
Yes	50	36	47	32	59	37	46	37	28	36	28	41	20	36	30	35
Pearson Chi-square	0		1.009		0.002		0		0.665		0.617		0.551		0.489	
p-value	.997a		.315a		.969a		.984a		.415a		.432a		.458a		.485a	

Results are based on nonempty rows and columns in each innermost subtable.

a More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.

Table O.8 Percentage of respondents commuting by non-car and car mode within groups using same transport route every time [%]. Pearson Chi-square test used.

Same Transport Mode Every Time	Non-car commuters								Commuters by car							
	Time		Cost		Effort		Generalised cost		Time		Cost		Effort		Generalised cost	
	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC	NEC	EC
No	18	14	16	15	20	15	17	15	13	15	14	15	4	17	14	15
Yes	40	28	36	27	47	29	37	28	19	34	25	32	16	30	22	34
Chi-square	0.146		0.866		0.635		0.188		0.912		0.546		2.529		1.583	
p-value	.930a		0.649		.728a		.910a		0.634		0.761		.282a		0.453	

Results are based on nonempty rows and columns in each innermost subtable.
a More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.
Table O.9 Percentage of respondents commuting by non-car and car mode within groups using same transport mode every time [%]. Pearson Chi-square test used.

If you could arrive at your work without commuting would you like to do so?	Reason for being a teleportation fan/ sceptic	TIME				COST				EFFORT				GEN COST			
		NEC	EC	Pearson Chi-square	p-value	NEC	EC	Pearson Chi-square	p-value	NEC	EC	Pearson Chi-square	p-value	NEC	EC	Pearson Chi-square	p-value
YES (Teleportation Fans)	Just to try it	18	16	0.218	0.641	16	18	0.119	0.730	24	15	2.465	0.116	16	18	0.118	0.731
	Saves time	37	43	1.200	0.273	39	44	0.351	0.553	37	41	0.431	0.511	39	42	0.361	0.548
	Saves money	16	14	0.324	0.569	14	15	0.040	0.842	8	17	2.193	0.139	15	14	0.092	0.762
	Saves effort	15	11	0.819	0.366	13	14	0.107	0.743	20	11	3.043	0.081	11	15	0.638	0.424
	Hate commute	6	8	0.291	0.590	7	7	0.003	0.958	14	5	4.768	.029a,*	6	9	0.907	0.341
	Other	1	1	0.032	.857a	1	1	0.330	.565a	0	1	1.440	.230a	1	1	0.049	.826a
NO (Teleportation Sceptics)	Doubt in it	3	3	0.001	.975a	4	1	1.857	.173a	2	3	0.645	.422a	4	2	1.940	.164a
	Need transition	9	10	0.023	0.881	11	6	2.098	0.148	6	10	0.989	.320a	10	9	0.153	0.696
	Like to exercise	6	13	2.677	0.102	13	3	5.696	.017*	6	11	0.919	.338a	10	10	0.002	0.968
	Enjoy commute	9	8	0.327	0.568	10	6	1.419	0.234	2	10	3.692	.055a	8	9	0.000	0.988
	Other	3	3	0.001	.975a	3	3	0.010	.922a	0	4	0.645	.422a	3	3	0.502	.478a

Table O.10 Teleportation fans and sceptics and their reasons for being “for” and “against” teleportation (more than one answer option available) [%]. Highlighted items significant at the 95% level, Pearson Chi-square test used.

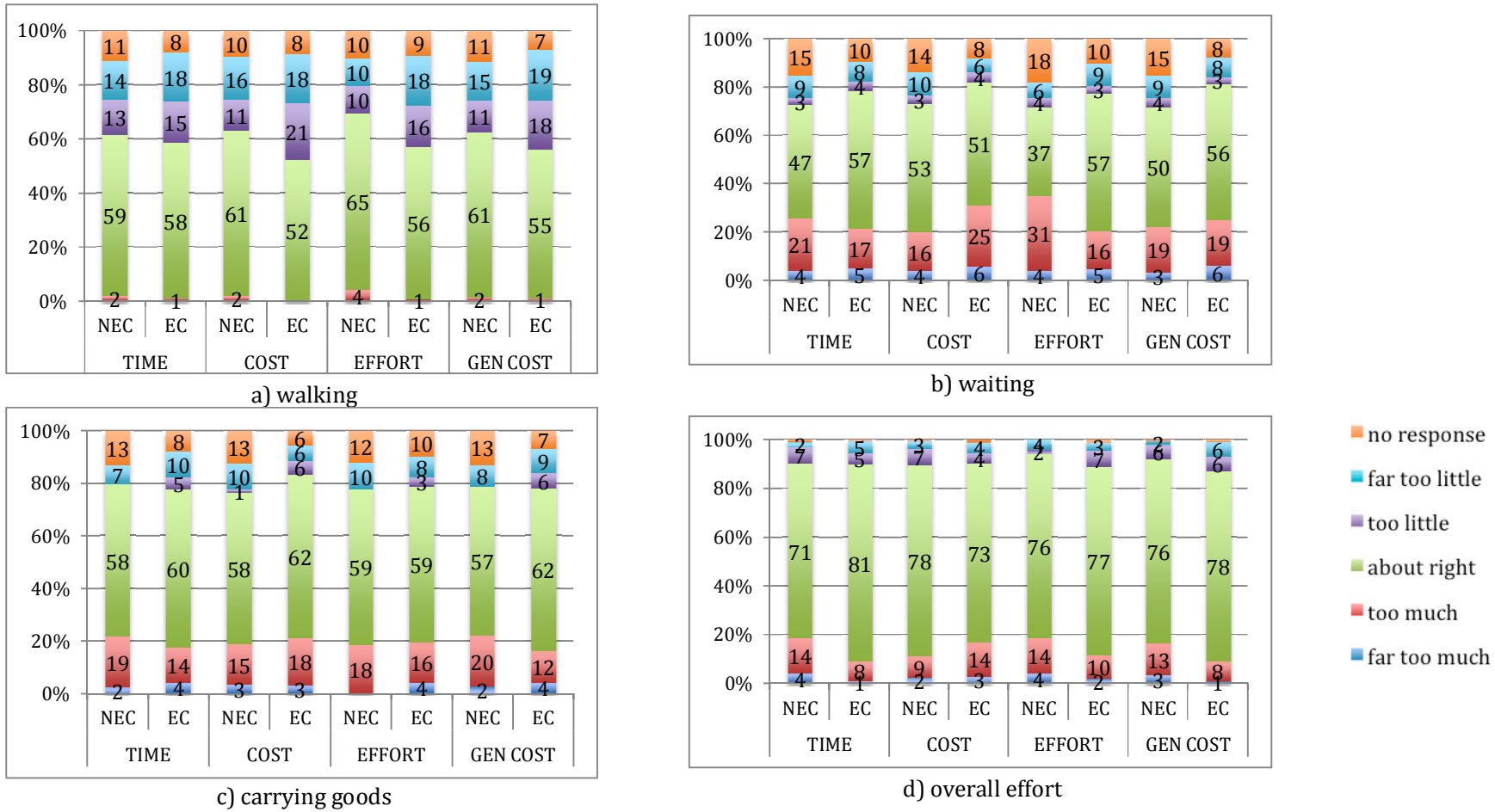

Figure O.1 Attitudes towards physical effort when travelling to work spent on: a) walking; b) waiting; c) carrying goods; d) overall effort [%]

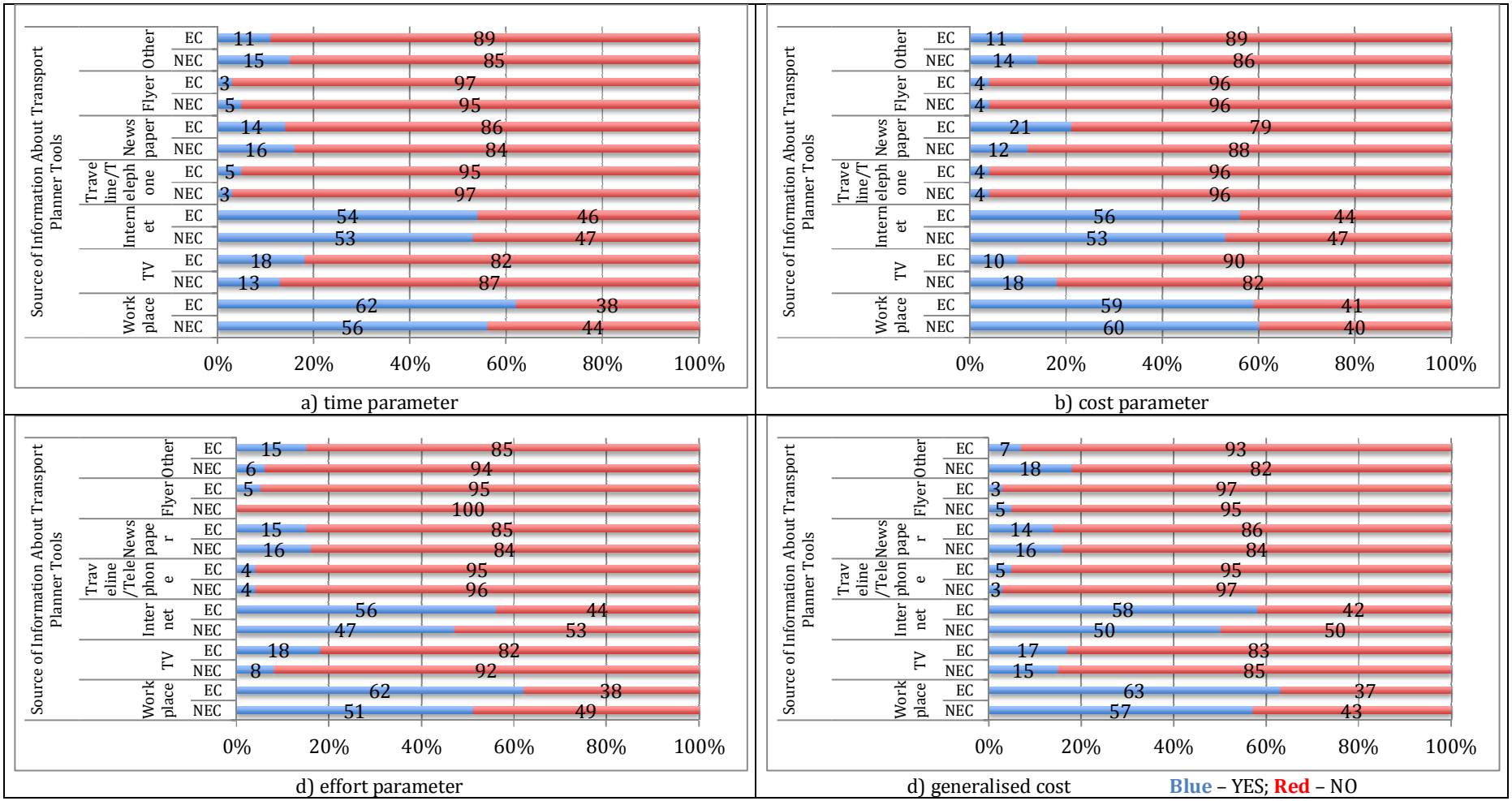

Figure O.2 Sources of information about transport planner tools [%]

Do you plan your journey to work in advance?	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
No	67	65	68	66	68	61	68	66	68
Yes	30	30	30	29	31	35	28	29	30
No response	4	5	2	5	1	4	3	5	2

Table O.11 Percentage of respondents undertaking advanced commute planning [%]

What do you plan/check before you start your commuting?	Total sample n=223	Time		Cost		Effort		Gen cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
Bag	10	10	10	11	7	8	10	10	10
Time	7	4	9	5	10	10	6	5	9
Entertainment	6	8	5	3	14	10	5	6	7
Lunch	4	7	2	5	4	10	3	5	4
Mode	7	4	9	6	8	2	8	7	7
Route	2	2	2	3	1	2	2	2	3
Weather	3	3	2	3	1	4	2	2	3
Total	**39**	**39**	**39**	**36**	**46**	**47**	**37**	**36**	**43**

Table O.12 What do you plan/check in advance before you start your commute? [%]

During commuting do you keep watching to check your progress?	Total sample n=223	Time		Cost		Effort		Gen cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
No	47	45	48	51	37	49	46	46	48
Yes	53	54	52	48	63	49	54	54	52
No response	0	1	0	1	0	2	0	1	0

Table O.13 Percentage of respondents who keep checking progress when on a commuting journey [%]

Transport Mode Switch in the Last 3 Years	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
No	73	72	73	74	69	80	71	74	71
Yes	27	28	27	26	31	20	29	26	29

Table O.14 Percentage of respondents who switched their transport mode to work in the last three years [%].

Reason Why Alternative Transport Modes Not Used	Total sample n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=49	EC n=174	NEC n=123	EC n=100
More time consuming	56	58	54	58	51	43	59	59	52
Pearson Chi-square test	-	0.46		1.01		4.13		0.95	
p-value	-	0.49		0.31		.042		0.32	
Parking problems	14	4	22	14	14	10	16	10	20
Pearson Chi-square test	-	14.99		0.006		0.87		4.70	
p-value	-	.00		0.93		0.34		.03	
Need of flexibility	27	21	31	22	38	22	28	22	33
Pearson Chi-square test	-	2.66		6.55		0.63		3.42	
p-value	-	0.10		.010		0.42		0.06	
More expensive	39	No statistically significant differences between NEC and EC within the groups ate the 95% level for these reasons							
Require more effort	19								
Less comfort	17								
Dislike public transport	8								
Bad for environment	8								
Current option safer	9								
Other	27								

Table O.15 Reasons why alternative transport mode not used [%]. More than one answer available. Highlighted results statistically significantly different at the 95% level between EC and NEC. Pearson Chi-square test used.

Reason Why Switched to the Current Transport Mode	Total n=223	Time		Cost		Effort		Generalised cost	
		NEC n=98	EC n=125	NEC n=152	EC n=71	NEC n=98	EC n=125	NEC n=152	EC n=71
Route changes	1	2	1	0	4	2	1	2	1
Current option cheaper	4	6	2	3	4	10	2	5	2
Bought a car	2	1	2	2	1	0	2	1	3
Need a car at work	3	2	3	3	3	0	3	2	4
Comfort	0	1	0	1	0	0	1	1	0
Fitness/health	6	5	6	7	4	0	7	6	6
New job/distance	4	4	3	3	4	6	3	5	2
Travel with partner/colleague	2	2	2	3	0	2	2	2	2
Other	8	6	9	8	7	6	8	7	9
No response	70	67	72	70	70	71	70	69	71

Table O.16 Reasons why respondents switched their transport mode to work in the last three years [%]