# An Investigation into the Role of Technology in Influencing the Perception and Value of Travel Time by Rail

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A thesis submitted for the degree of

Doctor of Philosophy in Transport at

Newcastle University

April 2014

# Abstract

The widespread ownership of Information and Communication Technology (ICT) devices and available access to power on trains has increased the potential of using travel time productively and thus, it is believed to influence the perceived travel time. In the 1980's train travellers on commuter trains were found to perceive travel time 8% higher than the actual travel time (Wilson, 1983), however, by 2007, travel time was considered to pass more quickly (Lyons *et al.*, 2007). The perception of travel time was believed to influence a passenger's attitude and behaviour, which in turn leads to a change in the value of time. Therefore, the aims of this research, firstly are to investigate how technology influences the perception of journey time and secondly to explore further the relationship between the perception and the value of travel time. In this way, whether or not technology influences the value of time will be established - an understanding of which potentially can influence decision-making regarding investment, operation and other policy interventions.

The data for this research was collected by interviewing passengers on-board of trains during their journey between Newcastle and London. The questions examined what passengers did and whether the use of ICT and entertainment media (represented by electronic devices) during their journey influenced their perception of travel time depending on the demographics of the different groups of passengers. Discrete choice analysis was conducted to model the trade-off between travel time and cost, and to estimate the value of time (VOT) of the travellers.

Based on the activity during the trip (electronic based (EB), non-electronic based (NEB), or personal engagement (PE)) it was found that those who engaged in the electronic based (EB) activities tend to perceive travel time as 10% higher than it actually is. The perceived travel time of the EB was the highest among the traveller groups. It was argued that rather than considering travel time as lost time, those engaged in the EB activities and who use travel time productively, assess the elapsed travel time based on what they have achieved or produced during their journey. The perceived travel time was high when the productivity was high. However, the study also found that the reliability of train services was the most important factor for travellers in choosing a train, and therefore, EB passengers did not accept any delay or increment of travel time and cost, even though they had the opportunity to use travel time more productively. Furthermore, the study found that those who engaged in EB activities have the highest VOT compared with other groups of travellers. However, some inconsistencies in the results emerged from the two-step cluster analysis, which revealed four passenger groups. The perception and VOT were shown to be driven by age, gender and the purpose of the trip. It was mainly students and elderly people clusters who perceived travel time as being equal to the actual time and who had the lowest VOT. It was mainly the females on business group emerged as having the lowest perception of time and second highest VOT, whilst the mainly males cluster had the highest VOT and the second highest perception.

The contribution of this study to knowledge has been to create statistically sound evidence of how the use of travel time influences perception based on face-to-face interviews whilst travelling. As far as the author aware, this methodological approach in this study has not been applied in previous research. The findings of this research have challenged the previous hypothesis that the use of technology decreases the perceived travel time and in turn leads to reduction in the VOT.

# Acknowledgements

First of all, I would like to express my sincere gratitude to my supervisors Dr Dilum Dissanayake, Lecturer in Transport Modelling, and Professor Margaret Carol Bell, Science City Professor of Transport and the Environment, for their guidance, encouragement, helpful comments and feedback and tireless effort to support during all stages of my research.

Secondly, my deepest appreciation is due to Mr Jim Muir, Retention & Insight Manager, and Mr Neal Smith, Head of Communications, of East Coast Mainline Company Ltd. for giving permission to conduct interview on-board of their train.

Special thanks are due to the members of the Transport Operations Research Group (TORG) and Indonesian community in the UK, for their help in data collection and constructive comments and suggestions concerning my research. I could not have been completed this research without their help.

I am also grateful to the Directorate General of Higher Education, Ministry of Education and Culture, Government of Republic of Indonesia for the financial assistance.

Above all, I would like to express my deepest appreciation to my parents, my wife and children, my brothers and sisters, and my friends, who stood beside me and supported me with their patience, motivation and prayers.

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# Chapter 1: Introduction

## 1.1 Introduction

Since the privatisation of railway operations in the UK by way of a Parliamentary Act in 1993 it has been increasingly important for operators to understand consumer needs. This is because within a competitive market there is continual pressure to invest in the provision of quality services that enhance the passenger experience and, therefore, ensuring financial viability. Vehicle technologies and costumer aspirations to travel change over time, are influencing their needs. As the population becomes older, circumstances change affecting the nature of the travel and their ability to pay. Whilst such changes occur for individuals others affect the whole population. An example of one of the most significant and far reaching influences on rail travel besides privatisation has been the introduction of information communication technology, including mobile phones, and portable computers.

Back in the 1980's, reading books and newspapers, talking and sleeping were the main activity during a train journey. As a consequence, Wilson (1980) found that, on average, travel time was perceived as being 8% higher than it actually was by train travellers. Although linear regression analysis of the data showed that the perceived and the actual travel time were not statistically significantly different at the 95% level of confidence, a time penalty of 1.6 minutes, irrespective of the duration of the journey was measured. This indicated that the perceived travel time was consistently higher than the actual time (Wilson, 1983). In contrast, in a more recent study by Lyons and Urry (2005) with the availability of personal electronic technologies, there was an increasing expectation that some changes in the travel time experience would be measurable.

Therefore, a qualitative study by Lyons *et al.* (2007) using a self-completion questionnaire, found that most people who used electronic devices during the journey considered travel time to pass more quickly.

A preference in the use of value of time (VOT) over perception of times emerged from some studies such as Wardman (2001), Gunn (2001) and Tapley *et al.* (2007) encouraging researchers to evaluate the effect on travel time of these technological advances as play changed passengers' travel time experience. The importance of such investigations on the perception of time and VOT has been increasing as the trend for productive use of travel time is rising (Lyons and Urry, 2005; Lyons *et al.*, 2007; Lyons *et al.*, 2012). ICT allows people to work anywhere and to share information and knowledge with anyone else in real-time, throughout the world (Lenz, 2005). Commuters can work at home become a so-called 'telecommuting' worker and companies can have multiple sites (Mokhtarian and Salomon, 1997). People can make a phone call to conduct business or arrange a meeting when they are travelling. On some modes, passengers have an opportunity to work using their laptop and connect to the Internet through Wi-Fi or 3G connections (Mokhtarian and Salomon, 1997).

Back in the 1970's, Bell (1976) pointed out that the perceived time is more important than the actual time for travellers when evaluating the performance of public transport services from the users' perspective. Furthermore, Lucas (2008) argued that robustness of the perception data is needed in today's research, as the perception of time influences the decisions made by travellers. As most of the VOT estimations were based on stated preference questionnaire surveys, respondents make a decision to choose one among several hypothetical alternatives. However, it is arguable that the VOT is driven by the perceived time rather than the actual time and therefore, this is an avenue that is explored in this research.

Lyons *et al.* (2007) and Lyons *et al.* (2012) attempted to investigate the effects of technology on how worthwhile the travel time is perceived by travellers. Ettema and Verschuren (2007) presented the evidence that those who engaged in listening to music whilst travelling had lower VOT than others. However, as far as the author is aware, no empirical study has been attempted to quantitatively estimate how quickly/slowly the time passes during the journey depending on the activities and electronic devices used, how the perceived travel time is influenced by opinion, attitude, feelings, and what its relationship with VOT is like.

### 1.2 Research Gap

Following many critiques on the use of VOT as the most important factor in estimating user benefit of a transportation project (Handy *et al.*, 2004; Lyons and Urry, 2005; Lyons *et al.*, 2007; Metz, 2008), further studies have been called for to present more evidence of the positive aspects of travel time and its relationship with VOT. The use of

VOT (specifically the value of travel time savings (VTTS)) in estimating user benefit was based on the assumption that time spent travelling is unproductive and should be reduced. Therefore the saved time can be used for more productive activities (Wilson, 1983; Ramjerdi *et al.*, 1996; DfT, 2009; Batley *et al.*, 2012).

Promising evidence with regards to the productive use of travel time, especially by train travellers had emerged (Ettema and Verschuren, 2007; Lyons *et al.*, 2007; Lyons *et al*., 2012). Furthermore, the decline in the trend of the VOT over time found by Wardman (2001) was expected to be due to the productive use of travel time enabled by the information age (Lyons and Urry, 2005). By ignoring the travel time use, and the fact that the positive use of travel time increases as the technology continuous to advance, Lyons and Urry (2005) suggested that invalid estimation of investment benefit occurs. However, in the context of these studies, the author found a lack of empirical evidence to support the idea of incorporating the travel time use into the VOT, which requires research with a different approach and perspective.

As many studies have attempted to discover the effects of travel time use and travel experience on the VOT, little attention has been given to investigating the effects of technology on the perception of time. An attempt made by Lyons *et al.* (2007) found that travel time passed more quickly when electronic devices were used. However, the study was based on qualitative research using a self-completion questionnaire distributed in several major stations in the UK. This was undertaken irrespective of being in advance of or after the journey, which potentially may have led to a bias in the perception and may not have been a true reflection of the actual experience of travellers during the actual journey. Furthermore, the study was not aimed at investigating the effect of travel time use on the VOT, despite examining whether the journey time was considered worthwhile or not because actual work had been achieved during the journey.

An attempt to investigate the effect of travel time use on the VOT was carried out by Ettema and Verschuren (2007), who found that those enjoying the journey through listening to music emerged as having the lowest VOT among all groups of travellers surveyed. Similar to Lyons *et al.* (2007), the latter study was based on a self-completion questionnaire distributed before or after the journey and therefore, was not directly based on the actual activity and perception of time when the journey was being made.

Therefore, this study attempted to fill this research gap by carrying out a comprehensive study of what effects the travellers' activity (with regard to whether or not technology has been used) during the journey has on the perception and VOT, and how these are influenced by attitude, opinion and feeling. The evidence obtained from this study is expected to evaluate the role of technology in influencing travel experience and thus, to move forward the debate between the VOT and the travel time use. Given that recent Stated Preference (SP) VOT surveys which demonstrated that the perception of the respondents played an important role (Ettema and Verschuren, 2007), this study focuses on whether the use of technology influences the perception of time, which in turn drives the VOT. Furthermore, if the use of technology reduces the perceive travel time, then this study will investigate how travellers respond to changes in travel time and travel costs. The more practical question is: would delay be less frustrating; or a small increase of travel time and travel cost being acceptable if free Wi-Fi is provided on-board? Such questions are addressed by this study.

## 1.3 Research Aim

The main aim of this study is to investigate how the availability of personal electronic device technologies influences the perceived travel time, attitudes/opinions and ultimately the VOT of the train travellers, in order to gain a fundamental understanding of the travel behaviour of public transport users.

## 1.4 Research Objectives

The specific objectives are:

1. To conduct a critical review on previous studies of travel behaviour of public transport users especially related to perception, attitude and the value of travel time to be able to explore the gap of knowledge and to set up a structured methodological framework to fill the gap.
2. To present additional evidence of productive use of travel time and its effects on the perceived travel time of the passenger.
3. To investigate the effects of using on-board technologies on the passenger perception of journey time compared to the actual travel time.

4. To examine the relationship between the use of technology whilst travelling and the attitudes and behaviours of travellers toward train services.
5. To investigate the effect of the use of technology on the VOT.

## 1.5 Thesis Contents

As an introduction to the key concept of the value of time (VOT) and its relationship with the perception and productive use of travel time, and the advancement of ICT, an extensive literature review is presented in Chapter 2 and Chapter 3. Chapter 2 is focused on findings the gap of knowledge in the topic. The discussion covers an overview of the fundamental theory of VOT, a review on the perception of time, positive utility of travel time and the effects of the use of ICT on travel time. Chapter 3 is focused on finding a structured methodology to fill the gaps of knowledge. In addition, a critical review is presented on a wide range of methodologies used in related studies.

Having provided the reader with background information on the gap found and the limitation of the methods used in the previous studies, the methodological approach used in this research is presented in Chapter 4. The methodological framework is presented in a flow diagram and described to guide the reader through the investigation approach that was adopted.

The processes involved in data collection are described in Chapter 5. Several evaluations on the questionnaire design and its influence on the final design are discussed and detail of the case study is described. The data cleaning process and preliminary analysis are presented in Chapter 6. Distribution of the samples are presented and compared to other studies.

Chapter 7 covers the investigation of the relationship between the perceived and the actual travel time. Linear regression models derived from the investigation are documented. The tendency to round the time to the nearest five minute intervals in estimation and its effects on the model are discussed. Statistical performances of the models are explained.

An investigation on the structure of data using cluster analysis is discussed in Chapter 8. The linear regression models of the relationship between the perceived and actual travel time by clusters are presented. A comparison of the perceptions of time between clusters is discussed.

An investigation of the effects of the perception of time on the attitude of travellers is discussed in Chapter 9. The use of factor analysis to reduce the number of variables is presented. Models of correlation between the ratio of the perceived-actual travel time and the factor solutions are documented.

The use of discrete choice analysis on the SP data is described in Chapter 10. The VOT estimated from the discrete choice model is presented. The effect of the main activity groups and clusters to the VOT are discussed.

Finally, a summary of the thesis is drawn and the key findings are presented in Chapter 11. The limitations of the study and direction for further research are discussed.

# Chapter 2: Overview of Travel Time Studies

## 2.1. Introduction

Over the years demand for transportation has been considered as a derived demand and travel time has been regarded as a sacrifice or a loss of time. People attempt to move from one location to another because of the necessity to satisfy the demand for goods, services or activities and in doing so sacrifice resources. People have no need to travel if what they need is available locally. These resources include money, time, wellbeing, comfort, and safety. This is referred to as generalised cost by researchers (Bruzelius, 1981; Wilson, 1983).

People tend to sacrifice specific resources to save others, which is referred to as a trade-off. For example, more money is paid for a more comfortable journey, common in rail travel, where first and second class tickets are available. Among the several variables involved in a journey, time and money are considered as the most important. Some people tend to spend/pay more money to save time and others accept longer journeys at less popular times in the day to save money. From the trade-off between time and money, researchers produce a terminology of the financial value of time or Value of Time (VOT) (Burge *et al.*, 2004; Antonio *et al.*, 2007; De Borger and Fosgerau, 2008; Huq, 2010; Batley *et al.*, 2012).

The VOT with the assumption that travel time is a lost (or wasted) time has been in at the heart of transportation studies for decades. However, several recent studies challenged the assumption as evidence showed that journey time is not always a loss of time (Mokhtarian and Salomon, 2001; Handy *et al.*, 2004; Lyons and Urry, 2005; Lyons *et al.*, 2007; Metz, 2008; Fickling *et al.*, 2009). In some cases, therefore, transportation is no longer considered as a derived demand, but instead travel time has a utility in the same way as activities conducted at the destination (Mokhtarian and Salomon, 2001; Ory and Mokhtarian, 2004; Mokhtarian, 2005).

This chapter elaborates the debate between the value and use of travel time from a theoretical perspective and highlights the issues. Section 2.2 presents the fundamental theory of the VOT; Section 2.3 provides an overview of recent studies of the VOT; next, the concept of travel time use as a positive utility is explained in Section 2.4

followed by the presentation of previous research of the perception of time in Section 2.5. Finally, the effects of information and communication technology (ICT) on travel time are discussed in Section 2.6 before justification of this research is explained in Section 2.7 and a summary of the chapter is presented in Section 2.7.

## 2.2. Fundamental Theory of the Value of Time (VOT)

VOT has been discussed since the 1960's and became more popular when Becker in 1965 published his theory of the allocation of time. Becker (1965) revised the traditional theory of choice which tends to separate production in industry and consumption in the household. According to Becker (1965), household are producers as well as consumers, because they implement the cost-minimisation and utility maximisation rules to combine market goods and time together to produce more basic commodities to consume such as sleeping and seeing a game. Furthermore, Becker (1965) postulated that the value of time would determine the amount of time allocated in consumption activities and work at the same level of income. When the value of time is increased as a consequence of any declination of other income, less time would be allocated at consumption and more at work to maintain the same level of income. The implication of the postulation is that consumption has a time cost of not earning money, which is the first concept and a basis for the use of the wage rate as estimated VOT (Jiang, 2003).

The use of wage rate in valuation of both work and leisure time equally was challenged by Johnson (1966), who included time for work and leisure directly into the utility function placing constraints on budget of time and money. Furthermore, Johnson (1966) extended the discussion of the VOT to its application on travel time. According to Johnson (1966), similar to time spent on work, time spent on a work trip also has a utility to allow the possibility that the travelling is desirable, and therefore, the use of the wage rate as an estimator of value of travelling time (hereafter referred as Value of Travel Time (VTT)) may lead on to a bias. Johnson (1966) suggested that the value of leisure and VTT must be lower than the money wage rate because it is subtracted by the subjective rate of substitution between income and work. In estimation of the VTT, Johnson (1966) suggested using the measured trade-off between time and money which is calculated as the ratio of the difference between cost and time.

Oort (1969) supported Johnson's theory that a work trip does have a utility value, especially when the time can be used productively or is relatively pleasant, however, in general people prefer to reduce it. According to Oort (1969), the use of the individual rate of pay as the basis for the estimation of the VTT would be sensible because a strong correlation exists between VTT and income. This was confirmed as Oort (1969) found that the value of reduction of travel time was about one third of the individual's rate of pay. However, many complications were acknowledged by Oort (1969) such as the effect of variation in journey length and vehicle comfort, and therefore more empirical research was called for.

DeSerpa (1971) introduced a theory that utility is a function of both commodities and the time allocated to them. In this theory, time similar to money is considered as a resource constraint in the individual decision-making process. As a constraint, there will be some minimum time required to be allocated to an activity. However, it is acknowledged that an individual may spend more time on a more desirable activity (DeSerpa, 1971).

Interestingly, Sharp (1983) proposed the concept of time in transport investment given that people perceive that transport has an intrinsic value. This mainly applies to those people who enjoy the travel experience and not simply interested in reaching a destination, which is most often the case. Sharp (1983) regarded time as "*raw material*" and whilst it can be transferred to alternative uses it cannot be saved to be used at a later date. Sharp (1983) criticised the assumption that travel time has a negative utility and should be minimised because people may have different preferences such as some might prefer to travel over spending extra time to work, but some may prefer otherwise.

In recent years, however, the debate on the transferability of the saved time to alternative uses such as more work or more travel was raised by Metz (2008) and commented by Givoni (2008); Ironmonger and Norman (2008); Lyons (2008); Mackie (2008); Noland (2008); Schwanen (2008); and van Wee and Rietveld (2008). Metz (2008) argued that instead of more work, the saving time is more likely to be used for more travel as in general people tend to have a fixed travel time budget of around one hour a day.

Numerous studies of VOT have been carried out over the past few decades and several countries have conducted their own, for example, in the United Kingdom in 1985 and 1994 (Mackie *et al.*, 2003), Netherlands in 1988 and again in 1997-1998 (Gunn *et al.*, 1999), Sweden in 1994 (Algers *et al.*, 1996), Norway in 1995-1996 (Ramjerdi, 1995; Ramjerdi *et al.*, 1996), and Switzerland in 2003 (Axhausen *et al.*, 2008). Also many studies focussed on a specific issue such as the VOT of a targeted user groups (Steimetz and Brownstone, 2005), or mode (Toner, 1991; Wardman, 2004), or activity while travelling (Jain and Lyons, 2008) and the relationship between the productive use and value of travel time (Fickling *et al.*, 2009). Apart from Jain and Lyons (2008), who discussed the intrinsic value of travel time, the main stream of research above, estimated the VOT based on the trade-off between time and money or consumers' willingness to pay to enjoy the reduction in journey time, which is referred to as the value of travel time saving (VTTS) without considering the productivity whilst travelling, except for Fickling *et al.* (2009). Studies on the value and the use of travel time are important to fundamental understanding which is required in policy making. The recent studies on the VTTS will be discussed in the Section 2.3 followed by a review on the intrinsic value of travel time or the productive use of travel time studies in Section 2.4.

## 2.3. Recent Studies on VOT

There is some evidence that amongst others the VTTS varies depending on income, individual and household characteristics (Gunn, 2001; Wardman, 2001; Tseng and Verhoef, 2008); distance and mode used and the purpose of the journey (Wardman, 2004; Tseng and Verhoef, 2008).

Gunn (2001) analysed data from three Revealed Preference (RP) and three Stated Preference (SP) studies together, in order to test spatial and temporal transferability of VTTS. The study found that the relationships between VTTS and the explanatory variables such as income, individual and household characteristics and free time, seemed stable and therefore, can be transferred over time and between regions. However, two interesting results emerged from the study that need further investigation. The first revealed zero value of small time savings suggesting only large savings are valued by travellers. The second noted a slight reduction in VTTS between 1988 and 1997 in the Dutch data, especially for train and bus/tram users on business trips, as shown in Table 2.1. However, the VTTS of the commuters and car users tended to increase. Comparing the environment of travel between the studies, it was suggested that the availability of the advanced personal information and communication technologies playing a role in the decline of the VTTS.

Table 2.1. VTTS in 1988 and 1997 by mode and purpose (1997 guilders).

| Mode | Commute | | Business* | | Other | |
|---|---|---|---|---|---|---|
| | 1988 | 1997 | 1988 | 1997 | 1988 | 1997 |
| Car | 13.87 | 14.51 | 45.76 | 50.18 | 11.07 | 9.99 |
| Train | 14.12 | 14.60 | 40.16 | 30.87 | 9.61 | 8.96 |
| Bus, Tram | 11.56 | 13.55 | 40.04 | 23.69 | 6.82 | 8.61 |
| Total | 13.75 | 14.43 | 45.64 | 48.37 | 10.59 | 9.64 |

*For this table, total business VTTS has been calculated, adding own-value to employer's value, being the net productive use of the saving.

Source: (Gunn, 2001)

Wardman (2001) reviewed a large number of VTTS studies in the UK and found that there was a slight decreasing trend in the VTTS over time between 1980 and 1996. The study indicated that the inter-temporal variation of the VTTS occurred because of the income growth, regardless of the changes in other socio-economic, demographic, attitudinal, employment status, and travel characteristics. It was also speculated that the decrease in the marginal utility of travel time was attributed to the use of mobile phones and laptop while travelling (Wardman, 2001; Tapley *et al.*, 2007).

Tapley *et al.* (2007) made an attempt to investigate how and why the VTTS varies over time in a study of data collected in 1994 and 2006, using the same questionnaire. In order to compare the results, the 2006 data was re-weighted to equalise the proportion of the data and to adjust the 2006 SP cost levels to 1994 prices by a factor equal to the inverse of the RPI (retail price index) increment between the dates of the two data. The study supported Wardman's (2001) findings, as it revealed that the VOT in 2006 was slightly lower than in 1994 (Tapley *et al.*, 2007)

Early studies found an increased income elasticity of VTTS over a number of years. Wardman, (2001) and Wardman (2004) found the VTTS were 0.51 and 0.72 respectively, whereas Shires and de Jong (2009) found it to be 0.62. The findings that the VTTS decreases over time therefore became questionable, as the income elasticity of VTTS increases over time. A more recent study using the datasets collected in 1994 and 2007 using identical SP experiments found that the income elasticity of the value of travel time is not uniform but increased with income, however, the income elasticity remained constant at the same level of income over time (Borjesson *et al.*, 2009).

According to Borjesson *et al.* (2009), when the income distribution shifts upwards over time, the average VTTS will grow at an increasing rate as well.

Abrantes and Wardman (2011) estimated the income (GDP per capita) elasticity of VTTS to be 0.9, highly significant when compared to the previous study. An income elasticity of less than one indicates the VTTS had decreased with income levels (Abrantes and Wardman, 2011) and therefore, support the finding that VTTS slightly decreases over time in Wardman's study (2001). Table 2.2 below shows income elasticity from several studies.

Table 2.2. Income elasticity in several studies

| **No.** | **Paper** | **Data** | **Methods** | **Income elasticity** |
|---|---|---|---|---|
| 1 | Wardman (2001) | Reviewed a large number of studies, primarily British between 1980 and 1996. | Meta-analysis | 0.51 |
| 2 | Wardman (2004) | British studies from 1963-2000 included data reviewed by Wardman (2001) | Meta-analysis | 0.72 |
| 3 | Shires and de Jong (2009) | Evidence from 77 studies covered 30 countries around the world and points in time (not specified in the paper) | Meta-analysis | 0.62 |
| 4 | Borjesson *et al.* (2009) | Data 1994 and repeated survey in 2007. | Repeated study | Income elasticity is not constant but increases with income. |
| 5 | Abrantes and Wardman (2011) | 226 UK studies carried out between 1960 and 2008. | Meta-analysis | 0.90 |

Source: Borjesson *et al.*, (2009) and Abrantes and Wardman (2011)

In the context of the value of travel time saving related to non-working time, Mackie *et al.* (2003) found that for car users, individual VTTS for a bus is higher than for a car, which was higher than for rail. However, Mackie *et al.* (2003) recommended that VTTS is differentiated by income instead of by mode. This is because VTTS reflects the combination of income differences between user types and self-selectivity. Self-selectivity means that an individual would change mode if his/her average-modal-value changes for example, if gasoline price increased they would use the bus rather than the car.

The lower VTTS of rail users is acceptable because during the train journey, people have the opportunity to use their travel time more productively compared to time spent driving or on a bus (as it is less comfortable) (Algers *et al.*, 1996; Gunn, 2001; Wardman, 2004; Borjesson *et al.*, 2009). The findings support the idea that the widespread ownership and use of mobile phones and the possibility of using a laptop during journeys by train/LRT lowers the VOT suggested by Wardman (2001).

In 2009, the UK government commissioned research on the effect of the productive use of travel time to the VTTS, which is published in Fickling *et al.* (2009). The study was motivated by the debate on whether the productive use of travel time reduced the VTTS, as discussed in Lyons and Urry (2005) and Lyons *et al.* (2007). This will be discussed in more detail in the next section.

Fickling *et al.* (2009) analysed a wide range aspects of a train journey such as ability to sit, crowded, ticket price, participants' activity whilst travelling, and used an SP questionnaire to estimate the VTTS of business travellers. The study found that on average, the employers' and employees' VOT are 4.4 and 17.8 respectively, which mean employees' gain four times more benefit of saving time compared with an employer. The study suggested that the use of a cost-savings approach in evaluating transport project benefit should be reviewed, as data did not support the assumption behind the approach (Fickling *et al.*, 2009). However, the study was focused on the implication of productive use of travel time by a segment of train users (business traveller), in the context of the economic appraisal and not for demand forecasting. Therefore many aspects were recommended for future research such as a study on other market segments (commuter and leisure journey), a travel behaviour aspect related to the productive use of travel time and exploration of evidence regularly.

## 2.4. Travel Time Used and Positive Utility of Travel Time

Instead of considering that travel time has a negative utility, Mokhtarian and Salomon (2001) suggested that travel time has a positive utility. The study found that not only activities conducted at the destination were a positive utility made possible by travelling, but also activities conducted during the journey. However, respondents are likely to consider all of the utilities together when choosing to travel. Therefore three components of utility namely utility for the activities conducted at the destination, for activities conducted whilst on the move and the utility for the travelling itself will influence how people react to the change in journey characteristics (Mokhtarian and Salomon, 2001).

Mokhtarian and Salomon (2001) emphasised that if travel time has a positive utility, then the idea that "*travel is a derived demand*" should be questioned. This is because it is ressential to enable the target activity at the destination. Mokhtarian and Salomon (2001) provided clear evidence that the proportion of the three components of utility varies by person and situation, even though the activities are the same. However, no measurement has been made to assess the proportion of the utility by travellers.

Previously, Mokhtarian and Salomon (1997) differentiated travel into utilitarian and undirected as shown in Figure 2.1. Utilitarian travel is when people choose the shortest or the fastest route. In this case, travel is completely ancillary given the primary goal is to arrive at the required destination. On the other hand, undirected travel is when people prefer to choose a longer or faster route because they enjoy the beauty of the scenary or there are other attractions along the route. Here travel was primary and the destination was ancillary. Furthermore it is possible that these two components are of equal or with a different balance of utility.

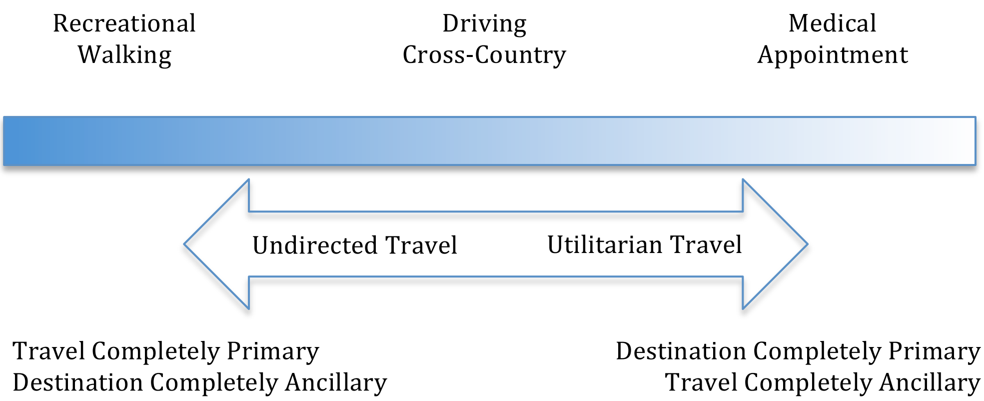



Figure 2.1 Relative degrees to which destination and travel are primary.

Source: Mokhtarian and Salomon, 1997

Mokhtarian and Solomon (1997) emphasised that:

> *"If a positive utility for travel exists at all, it is important to understand it better than we do now. How does such a positive regard for travel differ by personality type and other individual characteristics, by travel purpose, by mode and trip*

*length? Can we identify the impact a positive utility for travel has on the objective amount an individual travels?"*

The positive utility of travel time was also found in Ettema and Verschuren (2007), where travellers used their travel time to undertake activities such as read a book or listen to music. Whilst Lyons *et al.* (2007); Jain and Lyons (2008); Fickling *et al.* (2009) and Lyons *et al.* (2012) provided evidence of the existance of the positive utility of travel time, especially for train travellers, how it differs between travellers and what impact it has on the reason an individual travels, although this is still under research. Lyons *et al.* (2007) suggested that the positive utility of travel time will affect the VTTS. Metz (2008) suggested that the terminology of VTTS should be questioned as travel time no longer perceived as a loss of time. Wardman (2001) suggested that business travellers were more likely to receive benefit from the positive utility of travel time, whilst Ettema and Verschuren (2007) found that the positive utility of travel did not significantly affect the VTTS, except for those who enjoy music whilst travelling. Fickling *et al.* (2009), who considered the productive use of travel time in estimating the VOT of business travellers found that employee VOT is 4 times that of the employer.

Mokhtarian and Salomon (2001) suggested that people who enjoy travelling may consider the activities conducted whilst travelling as positive utilities of the journey. In some cases, the positive utility is a result of the absence of other activities as people can relax, but in other cases, travel time may be filled with other activities such as online shopping, making phone calls, reading or engaging in conversation.

Regarding attitude to travel (of those that enjoy travelling), as shown in Figure 2.2, Mokhtarian and Solomon (2001) found that more than 80% of respondents agree with the statement: "*It is nice to be able to do errands on the way to or from work.*" Only about 15% agreed with the statement: "*The only good thing about travelling is arriving at your destination*." Surprisingly, the study found that nearly equal proportion between those who agree, neutral and disagree with the statement: "*I use my commute time productively*." It is arguable that the finding is bias as the study did not consider the advantages of one mode over another such as the convenience to conduct a productive activity whilst travelling on a train compared to on a bus. However, the study provided evidence that the intrinsic utility for travel was existed and was recognised by a large portion of travellers.

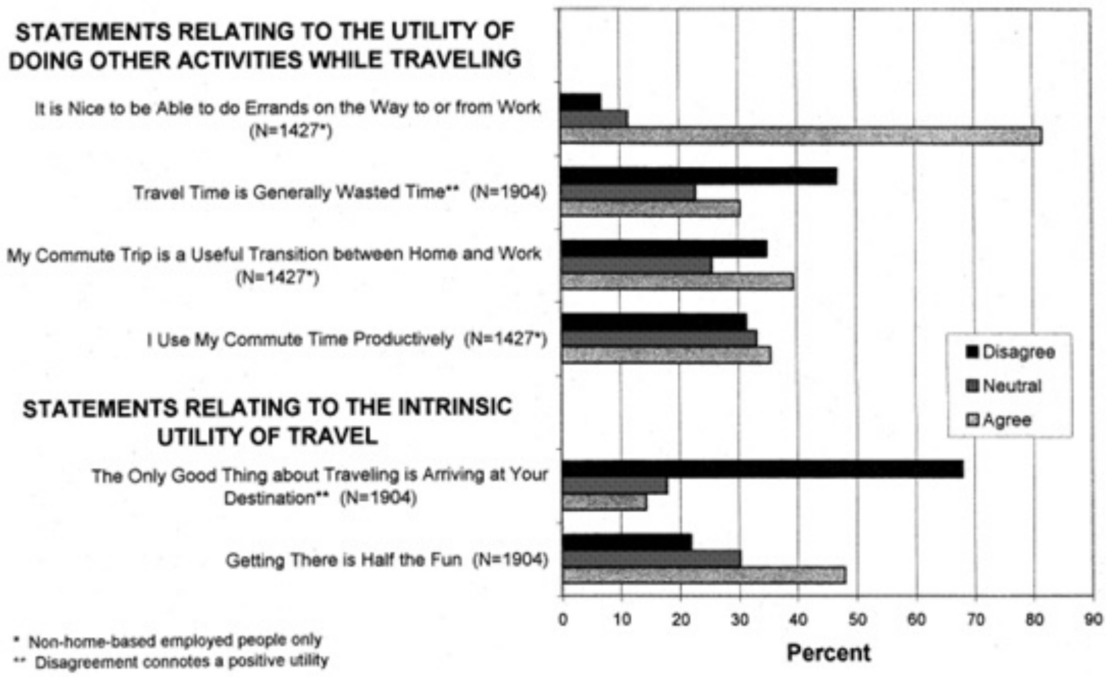



Figure 2.2 Attitude toward travel (Mokhtarian and Salomon, 2001)

Mokhtarian and Salomon (2001) hypothesised the unobserved "*desired level of mobility*" exists as a subset of the "*desired travel time budget*" (TTB). By using the terminology "*desired*", implicitely, Mokhtarian and Salomon (2001) suggested that people have a tendency to travel within their time budget, however, in reality, the travel may or may not be actually implemented. Both of these vary across individuals, and within the same individual across time. The study demonstrated that people seek to decrease their travel, only if the desired optimum was exceeded, conversely people seek to increase travel to reach their ideal. Therefore, instead of considering travel time as a cost, it is suggested that people tend to reach the amount of travel that is considered "*ideal*" (Mokhtarian and Salomon, 2001).

## 2.5. The Effects of ICT on Travel Time

The time during the 24 hours of the day will be allocated to several activities such as time to work, for leisure, consumption of goods, and all other activities including travel. Regarding travel time, Zahavi and Ryan (1980) claimed that each household has "*a stable/constant time and money budget to travel over time and space*". The travel monetary budget was found to be about 10-11% of income for car owner and 3-5% for households without a car. The travel time budget was about 6.75 hours a week or 0.96 hours a day (Zahavi and Ryan, 1980). This finding was supported by Metz (2008).

According to the constant time travel budget, each individual will allocate the same budget for travelling. In this context travel time saving from a particular journey will be used for another travel activity (Zahavi and Ryan, 1980; Mokhtarian and Chen, 2003). However, this theory has been questioned because research found that only a small amount of the time saving was used again for travel (Kitamura and Fujii, 1997). Over 89% of the time saved was applied both to in-home and out-of-home activities. Instead of fully agreeing with the travel time budget, Mokhtarian and Salomon (2001) proposed the concept an *"ideal amount of travel"* as a subset of the travel time budget. People will decrease travel time if the optimal amount of travel is exceeded but it will be increased if it is below the ideal (Mokhtarian and Salomon, 2001).

Nowadays, ICT has allowed people the opportunity to connect with each other electronically. Many studies have attempted to investigate the possibility of the availability of ICT reducing the importance of travelling (Mokhtarian, 1988; Mokhtarian, 1990; Srinivasan and Raghavender, 2006). ICT enables travel time itself to be used for productive work so that the loss of time can be decreased. This might influence the time allocation for each household. Golob and Regan (2001) discussed the potential impacts of ICTs on travel behaviour on several categories such as online shopping and services, making business arrangements and mobile working allowing individuals to reduce the disutility of travel by using ICT device such as mobile phones, laptops, and, increasingly, wireless-Internet-enabled versions of these devices (Mokhtarian and Chen, 2003).

Economic theory predicts that as the demand for one product decreases the demand for a substitute increases if the price rises relative to its substitute (Henderson, 1922; Kanafani, 1983). As the cost for travel increases and the charges for telecommunication decreases over time, telecommunication will become more financially viable alternative and thus, become favoured over travel. In fact, Mokhtarian (1990) and Choo *et al.* (2007) advocated that demand for both travel and telecommunication always increases over time and telecommunication can be both a substitute for and complementary to travel. In addition, new travel can be generated by the use of telecommunication, for example when a group of people make an appointment to meet at a certain place.

It has been confirmed for various reasons that in most cases travel time has a negative utility value and therefore should be minimised, as explained in terms of a generalised cost theory, as discussed in Bell (1976) and Wilson (1983). However, Lyons *et al.* (2007) presented evidence that travel time was used productively by one third of travellers. The productive use of travel time may reduce the negative utility of travel. From the perspective of travellers, the activity conducted whilst travelling may simply be considered as a distraction to make travel time more enjoyable, or conducted for an urgency reason such as completing the finishing touches to a presentation that will be delivered at the destination.

Lyons *et al.* (2007) conducted a self-completion mail back questionnaire to explore the types of activities in which travellers engage while travelling on the train. The questionnaire was part of the National Passenger Survey (NPS) wave in the autumn of 2004 carried out by Passenger Focus. A set of predefined options were presented and respondents were asked to select the one on which they had spent most time. The results of the study indicated that reading a book was the most popular activity among travellers. For those who were travelling on business, working and studying were the most prevalent and 13% of this cohort spent most of the travel time in these activities. This finding supported the hypothesis that business travellers gain more benefit from train journey as they can use their travel time more productively. The study found that only 2% of the respondents were bored and 1% anxious during the journey suggesting that in general, the journey was enjoyable for most of travellers. The study also indicated that there was a threshold of travel duration at which the suitable activity was to window gaze.

The potential use of travel time productively was predicted to increase by the widespread use of portable devices giving access to information, communication technologies (ICT) and entertainment media (Mokhtarian and Salomon, 2001; Zhang *et al.*, 2006; Ettema and Verschuren, 2007). The technology enables people to engage in several activities at the same time, as long as the activities are possible and desirable. Therefore in assessing personal travel behaviour it is important in this information age to consider the multitasking activities. Kenyon and Lyons (2007) noted that failure to consider multitasking leads to the underreporting of key activities and misinterpretation of group activity participation.

Lyons *et al.* (2012) attempted to compare the travel time use in the autumn 2004 and autumn 2010 of National Passenger Survey (NPS) data to establish whether option to work on the train has changed over time due to the advancement of mobile technology which makes working on the move convenient. The study revealed that the proportion of people in term of activities conducted whilst travelling were consistent between the 2004 and 2010 data as shown in Table 2.3.

Table 2.3. A comparison of travel time use in 2004 (in shaded rows) and in 2010. (Note: Data shown in the brackets were activities conducted for most of the time – only activities undertaken by at least 10% are shown).

| Activity | Journey purpose | | | |
|---|---|---|---|---|
| | All | Commute | Business | Leisure |
| Reading for leisure | 54 (38) | 63 (45) | 43 (25) | 48 (34) |
| | 54 (38) | 62 (46) | 47 (27) | 48 (32) |
| Window gazing/people watching | 53 (20) | 47 (12) | 46 (13) | 64 (32) |
| | 57 (20) | 49 (13) | 54 (14) | 68 (31) |
| Text messages/phone calls – personal | 30 (2) | 34 (2) | 26 (1) | 27 (2) |
| | 19 (1) | 20 (1) | 15 (1) | 19 (1) |
| Working/studying | 27 (13) | 31 (13) | 54 (34) | 11 (5) |
| | 26 (14) | 27 (14) | 52 (35) | 13 (6) |
| Listening to music/radio/podcast* | 20 (8) | 28 (10) | 14 (5) | 13 (6) |
| | 9 (4) | 12 (5) | 5 (1) | 7 (3) |
| Checking emails# | 17 (2) | 20 (2) | 31 (5) | 7 (1) |
| Eating/drinking | 17 (1) | 13 (0) | 23 (1) | 20 (1) |
| | 15 (0) | 9 (0) | 22 (1) | 20 (0) |
| Text messages/phone calls – work | 15 (1) | 17 (1) | 32 (3) | 5 (0) |
| | 8 (1) | 8 (1) | 21 (2) | 3 (0) |
| Talking to other passengers | 14 (5) | 10 (3) | 10 (5) | 19 (9) |
| | 15 (7) | 11 (4) | 13 (5) | 22 (10) |
| Being bored | 11 (2) | 14 (3) | 9 (1) | 11 (2) |
| | 12 (2) | 14 (3) | 9 (1) | 11 (2) |
| Internet browsing# | 10 (1) | 13 (1) | 11 (1) | 6 (1) |
| Sleeping/snoozing | 14 (3) | 18 (4) | 13 (3) | 10 (3) |
| | 15 (4) | 18 (5) | 13 (3) | 11 (2) |

*Podcast new to 2010 survey #new to 2010 survey

(Source: Lyons *et al.*, 2012)

Reading for leisure was still the most popular activity among travellers in 2010 followed by window gazing, and working or studying. The study found that the numbers of passengers equipped with electronic devices in 2010 was higher than in 2004, whilst on the contrary, those who were equipped with a newspaper in 2010 was lower than in 2004. However, those who were equipped with electronic devices may not usde them whilst travelling. For example, a laptop, despite the proportion of those who use one whilst travelling increasing by 70% in 2010, only one third of those who were equipped with one, reported using it. It is arguable that the situation on the train such as enough space or time to use it, determined whether the equipment could be used or not.

## 2.6. Perception of Time

Perception of time is an important factor that influences the value of time (Litman and Doherty, 2009) and is often used in the field of psychology to explain the way people relate their time to perform different tasks (Danckert and Allman, 2005). A time perspective refers to a relatively stable individual-differences process in the temporal frames used by individuals in tasks such as planning and decision making and it is determined by many learned factors such as cultural, educational, religious, social class and family (Zimbardo and Boyd, 1999).

Personal time perception is influenced by personality characteristics, such as time urgency, (when they need to finish something within the time) (Waller *et al.*, 2001), time perspective, (based on the attention to the past, present and future) (Zimbardo and Boyd, 1999) and personality type, (people who easily to get bored perceive time higher than others) (Danckert and Allman, 2005) as well as sex (Hancock and Rausch, 2009) and age (Coelho *et al.*, 2004).

Previous research by Waller *et al.* (2001) described that people with low time urgency usually lack awareness of time, whilst this is not the case for people with high time urgency, who use time effectively, make a prioritised task list so that they are rarely late in meeting deadlines. The personal characteristics described by Waller *et al.* (2001) base on time perspective and time urgency are shown in Table 2.4.

Table 2.4 Personal character based on time perspective and time urgency

| | | **Time Urgency** | |
|---|---|---|---|
| | | **Low** | **High** |
| **Time Perspective** | Present | Relators | Crammers |
| | Future | Visioners | Organiser |

Source: Waller *et al.* (2001)

Zimbardo and Boyd (1999) found that ambitious people put more weight on the future and spend most of their time working. The possibility to work anytime and anywhere as a benefit of advanced technology increases their time urgency and decreases their time for social activities, as this is perceived as a wasted time.

Danckert and Allman (2005) found that an individual with a personality that is prone to boredom tends to perceived time higher than those with a lower one. Hancock and Rausch (2009) found that a person's gender has a significant effect on the perception of time, and that a female is less accurate in estimating the passage of time as compared to a male. On average, a female tends to underestimate the passage of time by 2.5%, whilst a male tends to overestimate it by 10% (Hancock and Rausch, 2009). Coelho *et al.* (2004) found that the perception of time was influenced by age, where older participant perceived time higher than actual. However, Hancock and Rausch (2009) found that the effect of age on the perceived time was not significant.

Literature reveals little research in relation to the perception of time related to the transportation field. These include Wilson (1980); Wilson (1983); Bell (1976) and Mishalani *et al.* (2006).

Wilson (1980) was primarily concerned with the perception of time. Perhaps, this research is the first study which attempted to offer a '*social perspective*' on transport research as suggested by Lucas (2008).  The complete research findings where published in Wilson (1983). According to Wilson (1983), train travellers tend to perceive travel time as 8% higher than the actual time. Figure 2.3 shows the linear model relationship between perceived and actual time.

When comparing the result of this with current studies, it is reasonable to expect that the availability of information, communication, and multimedia technology has influenced the perception of time. Wilson (1983) conducted in 1980's was at a time when the traveller was limited in their activity options whilst travelling. The choice may be limited to non-electronic activities such as reading a printed book, writing, chatting with other passengers, looking at the view and personal reflection. These activities also may be considered as a productive use of travel time. However, for different reasons, the same may be true or otherwise when electronic devices are available. The fact that the study was conducted on a local train journey of 50 minutes duration limited the available time to conduct productive activities.

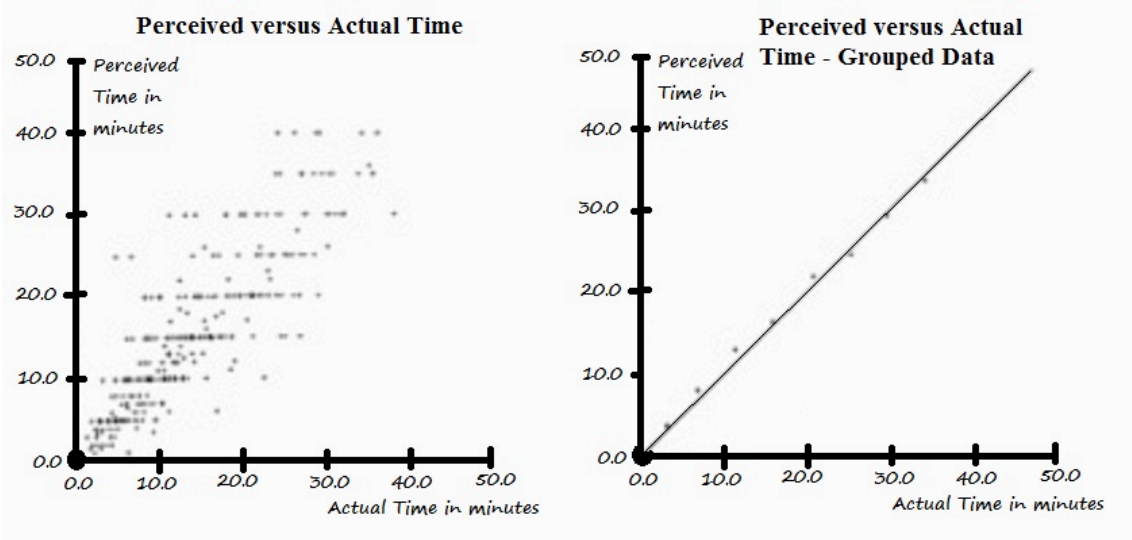



Figure 2.3 Relationship between perceived and actual time (reproduced from Wilson, 1983).

A later study by Ettema and Verschuren (2007) found that travel time is more enjoyable when listening to music, but the study did not estimate how the travel time was perceived. One could argue that the travel time passed more slowly in the 1980's, especially on a local train because of the limited activities and the journey, it could be argued was uncomfortable. Therefore, it seems reasonable to expect the perceived travel time to be higher than the actual.

This raises the question that as the opportunity to engage in activities whilst travelling increases, does rewarding travel time seem to pass more quickly? One may perceive time based on achievement; if substantial productivity is achieved, time seems to have passed more slowly. The situation might be different for those who enjoy the journey spending time listening to music. The perception of travel time is hypothesised to be different depending on the characteristics of the individual, journey characteristics, their activities whilst travelling and the level of service of the train. As far as the author is aware, no study has considered these factors in an investigation of how the perceived travel differs from actual time. Whilst Wilson (1983) studied the perceived travel time, concern has been taken in the difference in perception time for journey purposes rather than the above factors. This has motivated this research.

The second study on the perception of time was Mishalani *et al.* (2006). The study quantified the relationship between perceived and actual waiting time experienced by bus passengers at a bus stop on Campus Area Bus Service (CABS), Ohio State University in Columbus. For the services studied, the research revealed that actual waiting time was in the range of 3 to 15 minutes but the corresponding perception was greater than the actual waiting time. However, the models presented could not explain why the perceived time was greater than the actual time. It was suspected that the anxiety in waiting may lead to an increase in the perceived waiting time (Mishalani *et al.*, 2006 ).

Wilson (1980) and Mishalani *et al.* (2006) used the same technique in collecting the perceived time where participants were asked to estimate the elapsed time followed by some personal characteristics questions. However, neither of these studies investigated the effect of the perception of time on the attitude of participants, furthermore, they did not consider the productive use of time. The limitation in the availability of data prevented for further analysis.

When placing a value on travel time it is important to consider the perception, but it is not clear how the perception influences the valuation. Lyons and Urry (2007) showed evidence that travel time been perceived as worthwhile by most of travellers seems to pass more quickly when electronic devices were used, although it was not quantitatively measured. Ettema and Verschuren (2007) found that enjoying the trip by listening to music has a negative effect on the VOT by 69%. However, as discussed earlier, when the electronic devices are used to carry out more productive work, travel time may be perceived as being higher than the actual. Therefore, it follows that the value is high when the perceived travel time is high and vice versa when low.

## 2.7. Problem Statement

Several studies have been reviewed and presented in the previous sections such as the study on the perception of time carried out by Wilson (1983) and Mishalani *et al.* (2006), the VOT by Wardman (2004) and Wardman (2001), travel time use by Lyons *et al.* (2007) and Lyons *et al.* (2012), the effect of the use of personal technology devices to the VOT by Ettema and Verschuren (2007) and Fickling *et al.* (2009), and the effect of technology on travel demand by Mokhtarian and Salomon (20010 and Ory and Mokhtarian (2004).

When all of those studies were incorporated, in general there were five objects investigated in those studies: a) Perception of time, b) VOT, c) The use of travel time, d) Effect of technology on travel time experience, and e) Attitude of travellers.

All of the objects were expected to interconnect with each other. However, the studies investigated them separately as shown in Table 2.5. The study by Wilson (1983) did not consider the productive use of travel time as a result of advancement of personal technologies as that was not available at the time. Tapley (2008), Wardman (2004) and Wardman (2001) investigated the VOT and suggested that the productive use of travel time has influenced the VOT; however those studies did not investigate the relationship of both the use and the value of travel time.

Table 2.5 Comparison of the object of investigation of several studies on travel time

| No. | Object of Investigation | | | | | Example of Study |
|---|---|---|---|---|---|---|
| | **Perception of time** | **Travel Time Use** | **Value of Time** | **Attitude** | **Personal Technology Effect** | |
| 1. | Yes | No | No | No | Not available yet | Wilson (1983); Mishalani *et al.* (2006) |
| 2. | No | No | Yes | No | In discussion | Tapley (2008); Wardman (2004); Wardman (2001) |
| 3. | Yes, but qualitative | Yes | Yes, but qualitative | Yes | Yes | Lyons *et al.* (2007); Lyons *et al.* (2012) |
| 4. | Yes | No | No | No | No | Mishalani *et al.* (2006) |
| 5. | No | Yes | Yes | Yes | Yes | Ettema and Verschuren (2007) |
| 6 | No | Yes | Yes | No | Yes | Fickling *et al.* (2009) |
| 7. | No | Yes | No | Yes | Yes | Mokhtarian and Chen (2005); Ory and Mokhtarian (2004) |
| 8. | Yes | Yes | Yes | Yes | Yes | This study |

Lyons *et al.* (2007) and Lyons *et al.* (2012) investigated the use of travel time and its effect on the attitude of travellers, perception and value of travel time. Nevertheless, the study of perception of time and the value of time were conducted using a qualitative approach. The more comprehensive study was conducted by Ettema and Verschuren (2007), which investigated the relationship between attitude of travellers, the use and value of travel time, although, the study did not investigate the perception of time quantitatively. Fickling *et al.* (2009) investigate the effects of the productive use of travel time to the VOT but did not looking at the perception of time. Mokhtarian and Chen (2005) and Ory and Mokhtarian (2004) focused on the effects of the advancement of technology to travel experience and did not attempted to estimate the VOT.

Although the evidence of those studies seems to support the hypothesis that there is a strong relationship between the use of personal technology whilst travelling to the attitude of travellers, the perception and value of travel time, some issues still remain as the investigations were made separately. The first issue is why the hypothesis that the productive use of technology decreases the VOT was less likely to be supported by the evidence in Ettema and Verschuren (2007) except for those who engage in listening to music. Secondly, if travel time seems to pass more quickly when using electronic devices, why did some of the travellers who brought electronic devices whilst travelling, not use it (Lyons *et al.*, 2007). Thirdly, what is the role of technology in influencing the perception and value of travel time? An investigation into these objects simultaneously in a single study is important to explain the issues and therefore a motivation for this study.

## 2.8. Summary

This chapter reviewed a wide range of research topics surrounding the main subject of this study. Starting from the development of value of travel time theory, where travel time is considered to have no utility followed by the debate that in fact it has a positive utility. Finally, a discussion about the relationship between the perceived and value of time state was highlighted. Although many studies were conducted in the context of valuation of travel time, many areas remain for further research to be conducted.

The availability of advanced technology was shown to influence travel behaviour. Travel time was found not only as a means to reach the destination, but also considered as productive time engaging in work related tasks. What is the effect of a decrease in the disutility of travel time to the value of travel time? There is evidence to suggest that perception and the value of travel time has a relationship with the use of travel time. However, the limitations of the studies have resulted in an incomplete understanding of how travel time is perceived in the information age.

The author has no knowledge of a single study aimed to investigate the relationship between the use, the perception and the VOT and how these factors influence the attitude to train services. Early studies investigated separately or used inappropriate methods in gathering the information to obtain a comprehensive understanding of those relationships. Researchers such as Wilson (1983) investigated the relationship between the perceived and actual travel time without considering the use of electronic devices as they were unavailable at that time, Lyons *et al.* (2007) investigated the use of travel time in the UK but did not quantitatively estimate the VOT, Tapley (1998) investigated the variation of the VTTS without directly considering the productive use of travel time, Ettema and Verschuren (2007) investigated the relationship between the use and the value of travel time without considering the perceived travel time. Although Borjesson *et al.* (2009) suggested that the value of travel time remained constant over time, Wardman (2001) found the value of travel time decreases over time.

Some questions still remain, especially related to the role of information, communication, and multimedia technology in influencing the perception of time and the value of time. Furthermore, how the use and the value of travel time can be compromised in the valuation of investment benefit to users remains unclear with respect to Fickling *et al.* (2009). These call for new research to provide a more fundamental understanding.

The above motivated the research proposed in this thesis. It is important to obtain a deep understanding about the relationship between the use, the perception and the value of travel time and how attitudes to train services are influenced by those factors. This research expected to obtain new evidence, as a complement to the available evidence to move the discussion about the topic forwards. In order to develop an effective method to achieve the objectives, a wide range of methodologies are reviewed and discussed in the next chapter.

# Chapter 3: Methodological Review of Previous Studies

## 3.1 Introduction

A review of previous studies concerning productive use and value of travel time has been presented in the Chapter 2. Travel time was perceived as being 8% higher than the actual in the research of Wilson (1983). However, in recent year's qualitative research found that travel time has been perceived as passing more quickly than the actual when it was used more productively (Lyons *et al.,* 2007).

The trend of productive use of travel time was expected to increase because of the widespread ownership of advance technology, especially in information and communication equipment such as smart phones, laptops and Internet connection, especially by train travellers (Lyons and Urry, 2005). Ettema and Verschuren (2007) suggested that the use of personal information technology devices whilst travelling would influence the experience of the journey time, as travel time would become more enjoyable. However, there has been lack of evidence to confirm quantitatively that the perceived time has changed with the availability of personal information technology. In order to establish such empirical evidence, a carefully structured research methodology is needed. This requires a critical review of the relevant methodologies that have been used in previous research, and which is presented in this chapter.

## 3.2 Research on Perception of Time Studies

### *3.2.1 General*

The majority of studies on psychology or health related research, Gray and Gray (1975), Thomas and Weaver (1975), Lin *et al.* (2001), Danckert and Allman (2005), and Coelho *et al.* (2004) have attempted to learn how individuals perceive the passage of time. Only a few studies have investigated the perception of time in the area of transportation such as Wilson (1980) and Mishalani *et al.* (2006). According to Lucas (2008), Wilson (1980) is one of the first attempts that combined psychology with transportation research. This section provides a brief detailed description each of these studies.

Gray and Gray (1975) investigated the hypothesis that the perception of time would differ among introverts and extroverts based on their interest in carrying out a task. The task in this study was to spend three minutes time reading. The most important finding of the study was that the personality of the participants was not a significant effect in determining their perception of time. However, their interest in the reading task had significantly influenced the perceived time. Over estimation of time was exhibited by both introverts and extroverts when they were not interested in the reading task.

Thomas and Weaver (1975) examined the relationship between the perceived duration of time and variables of stimulus processing. Subject of the research were 20 paid undergraduates students at Stanford University. The variables were memory load and information level. Memory load was tested through asking respondents to memorise the stimulus which was presented using visual displays. This began with a 500-msec of screen showing no letter (named *Blank*), followed by a 1-sec dark interval and a 40 or 80 msec field either *Blank* or which contained three letters which formed a word (named *Word*) or a permutation (named *Perm*). The study found that the perceived time was less when the field is *Blank* than when the field contains three letters. It was hypothesised that *Perm* to be judged longer than *Word* as suggested by Avant *et al.* (1975) that familiarity of the visual stimulus is related negatively to perceived time. However, Thomas and Weaver (1975) found no evidence to support the hypothesis.

Lin *et al.* (2001) studied the relationship between patient satisfaction and perceived time spent with a physician in an academic primary care clinic. The study was motivated by the increasing tendency to limit the time that physicians had spent with patients in contemporary medical practice. The actual, the expected and the perceived duration of time spent with the physician as well as the satisfaction of the patients with the service, was collected during the survey. The results showed that the perceived duration of the time spent with physician influenced patient satisfaction with patients more satisfied when the perceived time was longer than expected and less satisfied when the time was perceived as being shorter than expected.

Danckert and Allman (2005) examined the effect of an individual's boredom levels on perception of time and the temporal allocation of attention. Temporal allocation of attention is a terminology used in psychology to explain how an individual allocates time to attend a task, which in this study was examined by asking participants to do an Attentional Blink Task.

In the task, 476 undergraduates students from the University of Waterloo were seated 65cm in front of computer screens which presented 14 alphanumeric stimulus at a rate of one every 100 msec, without any gaps. The subjects were asked to detect the presence of letters instead of numeral that appear two times during the task and press the corresponding letter on the keyboard at the end of the trial. On the other hand, the perception of time was assessed by asking subjects to estimate the time to finish each task. The study compared responses between high and low boredom prone individuals. However, the boredom level examined in this study was related to individual personality, not the actual boredom experienced during the study. Danckert and Allman (2005) found that individuals who experience low-levels of boredom tended to underestimate time more than high-level individuals. There was evidence that a higher absolute error in estimating time was demonstrated by high-boredom prone individuals. This suggested that the subjective perception of time was closely related to the experience of boredom.

Coelho *et al.* (2004) studied the effect of aging on the perception of time. During the study, participants of different ages between 15 to 90 years old were asked to conduct several tasks related to the perception of time such as estimating the elapsed time between two events or carried out a task within a specific time (will be discussed further in the next section). The study found that the older participants tended to misjudge the elapsed time as being longer than the actual.

Mishalani *et al.* (2006) investigated the differences between perceived and actual waiting time and its relationship with the socioeconomic variables of passengers awaiting the arrival of a bus at a bus stop. The findings of the study were expected to provide useful information related to the application of real-time bus arrival information. The hypothesis that under uncertainty because of the absence of accurate real-time information, the waiting time was expected to be perceived longer than the actual was found to be true through the F-test at a 0.01 level of significance. It is worth noting that using the t-test, the intercept of linear relationship of the perceive-actual time was statistically significantly different from 0 and the intercept was not statistically significantly different from 1. However, the findings were based on a range of 3 to 15 minutes duration of waiting time and therefore, may not be valid for waiting times longer than 15 minutes.

Wilson (1983) investigated travel time experienced by train passengers during journeys on a local train between Newcastle and Carlisle. Details of this study were given in Chapter 2 and the results showed that on average the perceived travel time was 8% higher than actual. However, when the linear regression analysis was applied to the data, the perceived travel time was not significantly different from the actual, although the intercept was significantly different from zero at the 90% level of confidence. The finding of this study was similar to that of Mishalani *et al.* (2006), where the slope of linear regression model was not significantly different from one (at the 90% level of confidence) and the intercept was significantly different from zero (at the 99% level of confidence).

The above studies showed that it is possible to assess the perception of time in transportation studies similar to those in psychology research. Section 3.2.2 below discusses further the details of the methodology used in data collection for the perception of time studies.

### *3.2.2 Data collection methods*

Most of the studies in the psychology and health area described above were conducted in a controlled environment and respondents were given a known stimulus. Studies in controlled conditions allow researchers to minimise unexpected variables and thus to influence the perception of time with consistency and reproducibility. However, this method cannot be used to capture the perception of time in real life conditions and is prone to bias as respondents are generally primed prior to the test. Paid participation sometimes leads to bias in responses as well especially if the research is politically motivated.

Table 3.1 shows the different techniques used in assessing the perceived time in previous research. In the field of psychology, the perceived time was found to be assessed by using two techniques.

Table 3.1 Perception of time in psychology research

| Study | Methods |
|---|---|
| Thomas and Weaver (1975) | - Respondents were asked to recognise short, medium and long periods of blank between two signals. |
| Gray and Gray (1975) | - 32 extrovert and 32 introvert college students were asked to read a book in 3 minutes. Some read 3 interesting books and some read 3 boring books. |
| Lin *et al.* (2001) | - Pre-visit: patients were asked their expected time spent with the doctor and how they perceived their overall health.<br>- Actual meeting durations were recorded.<br>- Post-visit: patients were asked about the duration of the meeting and whether they were satisfied with the meeting.<br>- The physicians were asked the perceived time spent with the patients. |
| Coelho *et al.* (2004) | - **The estimation test**: respondents were asked to verbally estimate the duration of empty time interval signalled by auditory beeps at 3 randomly assigned intervals and repeated 3 times each.<br>- **The production test**: respondent produce a time interval by asking examiner to stop counting when they think the target had reached.<br>- **The clock time test**: respondents were asked to draw a clock on a paper and asked how much time had elapsed between taking up the pen and finishing the drawing.<br>- **The global time test**: participants were asked to estimate total durations of the test.<br>- Measurement made was ratio of estimated and actual duration. |
| Danckert and Allman (2005) | - 476 respondents were seated 65cm in front of a computer screen per person to take 4 blocks of 48 trials.<br>- In each trial, the screen showed a rapid stream of 13 numbers and 1 letter or 12 number and 2 letters randomly at a rate of one every 100 msec with no gaps between stimuli.<br>- Subjects were required to detect the presence of target letters (T1 and T2) within the stream and press the corresponding letter on the keyboard at the end of the trial.<br>- Duration of trial to trial varied from 2 to 60 sec.<br>- Subjects were also required to estimate the duration of each trial. |
| O'Brien *et al.* (2011) | - Two groups of respondents were given a 10 minutes test playing with 21 x 11 matrix of random uppercase and lowercase letters.<br>▪ The first group received a fun task (assigning letters to form an English name).<br>▪ The second group received an uninteresting task (reproducing the matrix).<br>- Both groups were asked:<br>▪ to estimate the elapsed time after the completion of the task.<br>▪ to rate how fun and interesting the task was. |

The first technique was conducted by asking participants to estimate the passage of time and the second was conducted by asking participants to carry out a specific activity for a given time duration. Moreover, participants were instructed to stop the activity when that time was reached. The first technique was found to be more popular and has been used in several studies, including Avant *et al.* (1975); Gray and Gray (1975); Danckert and Allman (2005); and O'Brien *et al.* (2011), whilst Coelho *et al.* (2004) used both of the methods.

In the transportation area, Wilson (1980) and Mishalani *et al*. (2006) demonstrated the transferability of the method used in psychology to assess the perceived time, had an application in transportation research as shown in Table 3.2. More recently, the attempt to combine the psychological research into transportation research has been acknowledged by Lucas (2008). Lucas (2008) outlined that the contribution of social research in transport studies is highly important, in order to improve the understanding of people's travel choices.

Table 3.2 Perception of time in transportation research

| Study | Methods |
|---|---|
| Wilson (1983) and Wilson (1980) | - Interview took place on local trains between Newcastle and Carlisle.<br>- Perceived time was assessed by asking passengers the question: "without looking at your watch, how long have you been travelling on this train?"<br>- The time estimate was made in minutes.<br>- The actual travel time was recorded |
| Lyons and Urry (2005) | - Drawn hypothesis on the effect of the use of electronic devices to the perceived travel time. |
| Mishalani *et al.* (2006) | - Interview was conducted at bus stops.<br>- Time perception was assessed by asking respondents the question: "without looking at your watch, how long you have been waiting?"<br>- The time estimate was made in minutes.<br>- The actual waiting time was recorded. |
| Lyons *et al.* (2007) | - Data were collected by distributing a self-completion questionnaire at stations. |

Data used in Wilson (1980) was collected by interviewing passengers on a local train service during their journey between Newcastle and Hexham. The journey was about 50 minutes long. Using a one-page open questionnaire, the interview was started a few minutes after departure. The clock time was recorded as well as the perceived time. The perceived time was obtained by asking the respondents to estimate the passage of time between the train departing from station and the time when the estimate was made.

Mishalani *et al.* (2006) studied the perceived waiting time at a bus stop. Similar to the study by Wilson (1980), the participants were approached after waiting in line for a few minutes with the expectation that the interview would be completed before the bus they have been waiting for arrived. The actual waiting time was recorded during the survey.

Another method which provides a qualitative measure of time involves asking respondents how they rate the time experience, whether quicker or slower than the actual time. This technique was used in Lyons *et al.* (2007). However, this technique cannot be used to estimate the difference between the perceived and actual amount of time spent but instead the rate of passage of time.

### *3.2.3 Methods applicable for data analysis*

Linear regression relationship between the perceived and actual time has been discussed in Bell (1976), Wilson (1980) and Mishalani *et al.* (2006). Bell (1976) proposed a linear model of the perception of time at interchange which included service, foot walking, waiting time and penalty/threshold associated with interchange. Similarly, Wilson (1980) developed a linear model of the relationship between the perceived and actual travel time by train whilst Mishalani *et al.* (2006) discussed the perception of waiting time at bus stop.

Wilson (1983) used a linear regression model to develop the relationship between the perceived and the actual travel time. The model was as follows:

$T_t' = T_i + dT_t$ …………………………………………..……………...…………. (3.1)

Where:

$T_t'$ : the perceived travel time
$T_t$ : the actual travel time
$T_i$ : the constant "penalty/threshold time associated with interchange"
d : a coefficient

Bell (1976) formulated a relationship between the perceived an actual time as follow:

$$T'_{tf} = T_s{}' + T_f{}' + T_w{}' + T_i \text{ ......... (3.2)}$$

$T'_s = aT_s$

$T'_f = bT_f$

$T'_w = cT_w$

Therefore:

$$T'_{tf} = aT_s + bT_f + cT_w + T_i \text{ ......... (3.3)}$$

Where:

$T'_{tf}$ : the perceived time between leaving the feeder vehicle to the departure of the line-haul vehicle

$T_s{}'$ : the perceived service time needed to purchase tickets, get information etc.

$T_f{}'$ : the perceived time on foot walking in the interchange

$T_w{}'$ : the perceived time waiting for the next required vehicle to depart

$T_i$ : the constant penalty/threshold time associated with interchange

$T_s$ : the actual service time.

$T_f$ : the actual time on foot walking.

$T_w$ : the actual time waiting.

*a, b, c* : coefficient

Mishalani *et al.* (2006) developed a simple linear regression model in a study in the USA as follows:

$$T'_w = T_i + eT_w \text{ ......... (3.4)}$$

where:

$T_w{}'$ : the perceived waiting time.

$T_w$ : the actual waiting time.

$T_i$ : the constant penalty/threshold time associated with interchange

e : coefficient

The studies discussed above used a simple linear regression method in their analysis. It is reasonable to expect that the perceived time has a linear relationship with the actual. However, depending on the data, it is possible to have a non-linear relationship, for example, when the journey is delayed and the expected arrival time has passed (Mishalani *et al.*, 2006). Figure 3.1 shows the hypothetical situation where the first short amount of time is not perceived and then the perception of time increases with the actual, until the expected time is reached. As the expected time passes, the perceived time increases rapidly until the maximum accepted time is reached before the individual make a new decision as to whether to keep waiting or to leave.

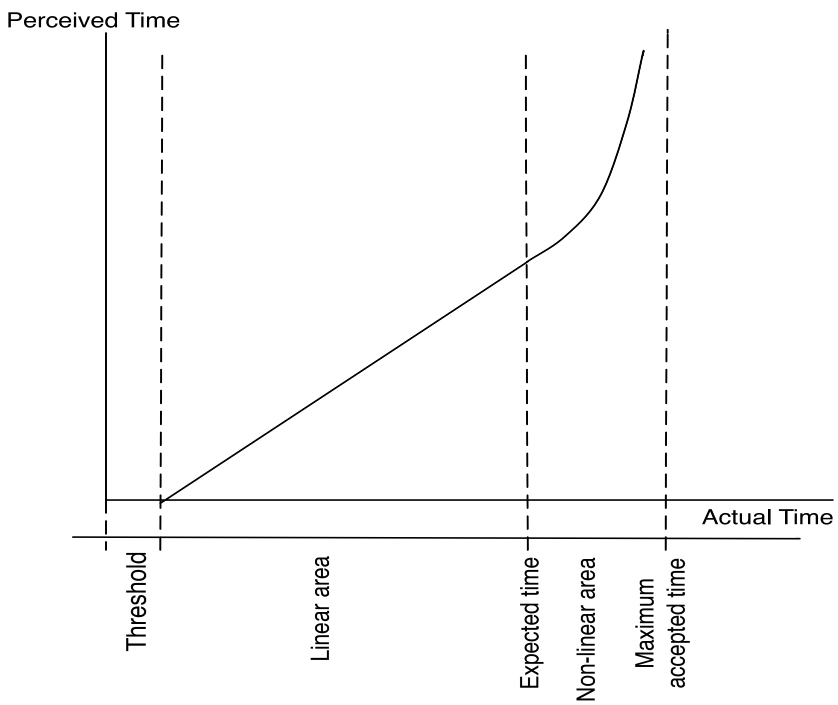



Figure 3.1 Hypothetical function of perception of time (illustrated from Mishalani *et al.,* 2006)

It is also possible to consider other factors that influence the perception of time such as socio-demographics, the main activity and journey characteristics such as age, gender, respondents' activity whilst travelling and the purpose of the journey. The information, communication and entertainment technologies have not been taken into consideration in the studies by Wilson (1980), Bell (1976) as these studies were conducted before the advancement of these technologies, however it is surprising that there were not considered or commented on by Mishalani *et al.* (2006). Perhaps, this is because the waiting time was only 3 to 15 minutes, which was considered too short to be able to use the technology. In this study it was useful to explore the relationships between the perceived and actual travel time considered journey characteristics, attitude and socio-demographics of the respondents in relationship to the availability of advanced mobile technology.

## 3.3 Research on Investigating Attitudes, Opinions and Experiences of Travel Time

### *3.3.1 General*

In travel time studies, it is important to investigate respondents' attitudes towards and opinion and experience of train services to evaluate the transport system or policy (Crano and Prislin, 2008). In transportation studies, several attempts have been made to investigate passenger attitudes, opinions and experiences of travel time in the recent years (for example Lyons and Urry (2005); Ettema and Verschuren (2007); Lyons *et al.* (2007); Jain and Lyons (2008); Russell *et al.* (2011) and Passenger-Focus (2012)).

There were many definitions of attitude in literatures. One of them was suggested by Eagly and Chaiken (1993) as a psychological tendency expressed by evaluating a particular entity with some degree of favour or disfavour. However, Cacioppo and Tassinary (1989) suggested the best-known conceptualisation of attitudes was that of Rosenberg and Hovland (1960):

> "Attitudes are predisposition to respond to some class of stimuli with certain classes of responses and designate the three major type of response as cognitive, affective, and behavioural." (Rosenberg and Hovland, 1960, p. 3).

Regarding travel time studies, researchers recognised that travel time can be used for other purposes such as preparing documents for a meeting or planning an itinerary for holiday (DeSerpa, 1971; Bell, 1976; Wilson, 1983; Wardman, 1998; Wardman, 2001). In assuming that the time can be used to achieve something, it is argued that travel time has value. However, Bell (1976) and DeSerpa (1971) conducted their study at the time when the use of travel time for other purposes was very limited and was not supported by technology. Therefore, it is arguable as to whether to neglect its impact on travel time studies. Wardman (1998) and Wardman (2001) studied the value of travel time savings which neglected the use of travel time by assuming travel time as a lost time.

Lyons and Urry (2005) was one of the first to challenge the conventional value of travel time concept which is that travel time is a loss of time. They argued that travel time can be use to conduct productive activities. Furthermore, the potential of productive use of travel time was expected to increase in the future as information technology continuous to advance. Further study provided some evidence that the travel time has been used productively (Lyons *et al.*, 2007).

Lyons *et al.* (2007) investigated train passengers experiences depending on the use they made of travel time. Referred to as productive use of travel time it was expected that activity influences travel time experiences and governed whether the journey time was considered worthwhile or not. It was demonstrated that the productive use of travel time was highly correlated with the satisfaction of journey time, as respondents felt the travel time was worthwhile (Jain and Lyons, 2008).

### *3.3.2 Data collection methods*

There are several methods available for conducting studies in relation to attitude, opinion and experience towards the transportation service such as the self-completion questionnaire, face-to-face interviews, passenger observation and focus groups (Oppenheim, 1992). This section reviews several studies related to travel time experiences, incorporating some details of the data collection methods for those studies. Table 3.3 shows the summary of data collection methodologies used in several travel time experience studies.

A self-completion questionnaire had been used in data collection in Lyons *et al.* (2007). The questionnaire was distributed at major rail stations around the UK. A prepaid envelope was attached to return the completed questionnaire by post. The respondents were asked to answer two questions regarding their travel time use. The first question aimed to investigate the activities conducted by respondents whilst travelling. Respondents were presented a list of possible activities to be conducted on the train and were asked to indicate all of their activities whilst travelling. The second question aimed to identify their main activity and asked to choose from the list, the one activity that was conducted for most of the time during the journey. A similar technique was used or discussed in more recent studies such as Ettema and Verschuren (2007), Wiles *et al.* (2008) and Fickling *et al.* (2009).

Direct observation of passenger behaviour is another technique that would be useful to inform passengers' behaviour and experiences. A camera is a useful tool to record all of the activity of passengers and then at a subsequent date the observer replays the film and makes notes from the recorded tape. However, due to ethical issues, the use of a camera recorder needs a consent statement from the passengers. The use of a camera in public transport without any consent of the passengers can violate the research ethics (Wiles *et al.*, 2008). This is because a research should be based on voluntary informed consent and personal information should be treated confidentially with the participants being anonymised (Wiles *et al.*, 2008).

As an alternative, the observer may sit at the front of a carriage facing backwards and study the activities conducted by other passengers at a certain interval of time. This structured observation method has been used in travel time use studies, for example a study of bus passenger behaviour in New Zealand (Russell *et al.*, 2011). However, this technique can only assess physical activities that can be seen visually and does not provide information in relation to the passengers' attitude and motivation.

Other techniques in data collection for travel time use are focus groups, ethnography, travel time diaries and short videos (Watts and Urry, 2008). Focus groups are one of common methods in social research to explore the perceptions, beliefs, opinions, and attitudes towards something (Bloor *et al.*, 2001). Ethnography is a useful method for revealing the richness of the travel experience and the contextual setting (Pawluch *et al.*, 2005). However, these techniques (focus group and ethnography) are qualitative methods so they cannot be used to assess the amount of the activity and the experiences providing measures such as duration, type of activities, common behaviours and how they differ among population groups. Therefore, these techniques are not relevant to this study and will not be discussed further in this review.

On the other hand travel diaries may capture more detail, including visible and invisible, such as participant's attitude and experience during the journey, including what they thought, did and interests. This is because travel diaries are written by a participant regularly to express their attitude, experiences and the reason behind every decision they made. However, it is challenging in transferring the diary into publication because of the nature of travel diaries is not in a scientific form and it is difficult to justify.

Table 3.3 Methods in travel time experience studies

| **Methods** | **Advantages** | **Disadvantages** | **Examples of Studies** |
|---|---|---|---|
| Self-completion questionnaire (passenger survey) | - Less expensive.<br>- Potential to get a large sample.<br>- Respondents are less disturbed. | - Respondents may have forgotten their activity on the journey. | Ettema and Verschuren (2007); (Lyons *et al.*, 2007) |
| Interview whilst travelling | - Participants can ask for more detail about the question being asked.<br>- The reported activity is real as the participant is still on the journey. | - Only record activity on a part of the journey. | Wilson (1980) |
| Structured observations | - Can capture activities of objects time to time, so duration of activity can be recorded. | - Expensive as more observers needed to increase number of sample.<br>- Bias in behaviour of participants, as they know that they are being observed. | Block *et al.* (2000) |
| Focus groups | - Can explore opinions, attitudes, and perceptions of participants.<br>- Respondents can interact with each other so the discussion can be deeper and deeper. | - Takes time to make transcription of the discussion.<br>- Data is qualitative. | Jain and Lyons (2008) |
| Ethnography | - Can be used to record why and how participants do something and in what setting it happened.<br>- Capture the whole journey. | - Expensive as observer should follow participants.<br>- Ethics issues<br>- Recruiting participants and getting permission is challenging. | Pawluch *et al.* (2005) |

The same problem also rises with the use of short videos. Whilst all visible activity can be collected it was difficult to publish it in a journal without the involvement of other methods to explain the reason behind the activity conducted.

According to the author, when investigating the passengers' attitudes in relation to their activity simultaneously with the perceptions of the passage of time, the best method would be to conduct the interview whilst travelling. Interview methods allow researchers to obtain perceptions, attitudes, and activities of respondents related to the actual conditions. In this study, the interviews were carried out whilst travelling on a train at random point durations of the journey.

Table 3.4 Aggregation rule

| No. | Rule | Advantage | Disadvantage |
|---|---|---|---|
| 1 | Median (Thurstone, 1928) | The median is the most stable estimate when a small sample was obtained for each object. | |
| 2 | Sums-of-products (Fishbein, 1967; Rosenberg, 1956) | The index ranges from positive to negative. | People tend to use average rather than sums of products. |
| 3 | Weighted averaging rule (Anderson, 1981) | | This rule does not apply to the spontaneous sampling of people's thoughts. |
| 4 | Based on one or two of the most important thought about object (Ebbesen, 1981; Ostrom, 1981) | | |

Source: (Pratkanis *et al.*, 1989)

The attitude of travellers is usually captured by asking respondents to rate several statements based on their preferences. Response can be expressed by making a rank order of the attributes or rating the preferences on what is known as a Likert-scale. Likert-scale is a psychometric scale invented by Rensis Likert to capture the intensity of respondents' feelings on a scale of agreement or disagreement, as a response to a Likert questionnaire, for example score 1 refer to as strongly disagree and score 5 refer to as strongly agree. Detail of this technique can be found in Likert (1932).

There were several suggestions on the aggregation rule of the Likert scale of the attitudinal data, in particular when a rating scale was used to express responses as shown in Table 3.4.

According to Thurstone  (1931), the use of the median is more preferable and would be the most stable estimate.

When defining the scale, Dawes (2002) suggested that the purpose of the study has to be taken into consideration. Dawes (2002) found that there was no difference in mean of a 5 or 11 point scale; however, the 11 point scale produced more variance. The statistical significance level of the results were unknown. Dawes (2008) found that there was no statistically significantly difference of mean between the 5 and 7 point scale but that 10 point scale has a lower mean. According to Dawes (2002), more categories are more useful when the dependence relationship between scale variables is examined using regression analysis.

Garland (1991) stated that an unacceptable answer could be minimised by eliminating the mid-point. Dawes (2001) found that the midpoint led to a lower score being achieved. However, eliminating the midpoint would also lead to a bias as participants are forced to agree or disagree (Johns, 2005).

### *3.3.3 Methods applicable for data analysis*

This section discusses the methods most commonly used in analysing attitudinal data namely Cluster, Factor, and Important-Satisfaction Analysis. Cluster Analysis (CA) is used to explore the structure of data and classifies similar data objects in a group based on some criteria (Everitt *et al.*, 2001). Factor Analysis (FA) is used to determine the number and nature of latent variables or factors that account for the variation and co-variation among a set of observed measures, commonly referred to as *indicators* (Brown, 2006). On the other hand Importance-Satisfaction Analysis (ISA) is an application of the Importance-Performance Analysis (IPA) to the internal operational focus such as the management of human resources (Graf *et al.*, 1992). IPA is a technique that identifies strengths and weakness of brands, products, and services by comparing the relative importance of attributes and consumers' evaluation of the offering, in terms of those attributes (Martilla and James, 1977).

### *A. Exploring the structure of the data using cluster analysis*

In data mining, researchers have shown interest in assigning individuals or objects into categories that are similar to each other or share many characteristics that are different from individuals in other groups. The clustering makes it easier to understand and identify pattern draw conclusions and make recommendations regarding the characteristics of each category, group or cluster. Deciding on the number of clusters is a trade-off between understanding the communality in the group, the possibilities to understand them easily, the subtleties in the differences and the statistical confidence of the resulting set.

Mooi and Sarstedt (2011) define cluster analysis as *a convenient method for identifying homogenous groups of objects called clusters*. The homogeneity or similarity is measured using the strength of the relationship (also known as similarity measures) or using the distance between the pair of objects (often referred to as distance measures). The smaller the distance the more similar the objects are within the cluster. A brief explanation of the steps in the cluster analysis methods is given below, however more detail can be found in cluster analysis books such as Mooi and Sarstedt (2011), Tryon and Bailey (1970) and Everitt *et al.*, (2011).

There are three commonly used clustering methods: Hierarchical Methods, Partitioning Methods and Two-step Clustering.

Hierarchical Cluster Analysis

In this clustering procedure, the objects consecutively form clusters. There are two types of hierarchical technique: agglomerative clustering, where each object represent a cluster and then is sequentially merged according to their similarity, and divisive clustering, where a cluster is generated top-down from a single cluster, gradually splitting up to some clusters at the lower level. However, the agglomerative clustering is more popular and often used in market research (Mooi and Starstedt, 2011).

Hierarchical cluster analysis uses Euclidean distance as a measurement for the similarity. The Euclidean distance uses a straight line between two objects to assess their proximity. Imagine B and C are two individual measures of a variable availability in a study, the proximity (referred to as d(B,C)) of the variables x and y is calculated using the equation below:

$$d_{Euclidean}(B,C) = \sqrt{(X_B - X_C)^2 + (Y_B - Y_C)^2} \quad \text{.........................................} \quad (3.5)$$

where:

$d_{Euclidean}$(B,C) = Euclidean distance between individual B and C
$X_B$ and $X_C$ = Value of variable X for individual B and C respectively
$Y_B$ and $Y_C$ = Value of variable Y for individual B and C respectively

The distance between all pairs of data can be computed in the same way and written by means of a distance matrix.

Other methods in assessing the distance are City-block-distance and the *Chebychev* distance. The city-block-distance uses the sum of the variable's absolute differences whilst the *Chebychev* distance uses the maximum difference of the absolute difference in the clustering variables. Milligan and Cooper (1988) recommended using standardization by range, in order to avoid distortion of the analysis results when mixing data between different scales of data.

City block distance uses the sum of the variables' absolute difference to measure the similarity.

$$d_{ij} = \sum_{k=1}^{n} \left| X_{ik} - X_{jk} \right| = \left| X_B - X_C \right| + \left| Y_B - Y_C \right| \quad \text{.........................................} \quad (3.6)$$

Where:
$d_{ij}$ = City block distance between i and j
$X_{ik}$ = Coordinate attribute k of point i
$X_{jk}$ = Coordinate attribute k of point j
$X_B$ and $Y_B$ = Coordinate B
$X_C$ and $Y_C$ = Coordinate C

Chebychev is also referred to as an absolute value distance because it uses the '*absolute differences in the clustering variables*' values as a measurement of the similarity.

$$d_{Chebychev}(i,j) = \text{Max}i|X_k - Y_k| \quad (3.7)$$

where $X_i$ and $X_j$ are the values of the $i$th variable at points X and Y, respectively.

Partitioning Method: K-Means

The K-Means clustering procedure uses the within-cluster variation as a measure to form a homogenous cluster (Mooi and Sarstedt, 2011). Initially the objects are assigned to a pre-decided number of clusters, then successively reassigned to other clusters to minimise the within-cluster variation. Within-cluster variation is measured based on the squared distance from each object to the centre of the associated cluster. The objects will be reassigned to a different cluster if doing so decreases the within-cluster variation.

According to Mooi and Sarstedt (2011) this method is superior to hierarchical methods, as it is less affected by outliers, and the presence of irrelevant clustering variables, can be applied to very large datasets (more than 500) because it is less computationally demanding. The procedures should only be used on interval or ratio-scaled data because it relies on Euclidean distances (Mooi and Sarstedt, 2011).

Two-Step Clustering

The two-step cluster analysis is designed to handle mixed variables measured on different scale levels. As the name indicates, there are two steps in the algorithm: firstly, algorithm undertakes a procedure that is very similar to the k-means algorithm; and secondly, it conducts a hierarchical agglomerative clustering procedure in forming homogenous clusters. Researchers can specify the number of retained clusters or set the maximum number of clusters where the procedures is allowed to automatically choose the number of clusters bases on statistical evaluation criteria such as Akaike's Information Criterion (AIC) or Bayes Information Criterion (BIC).

$$\text{AIC} = [-2logL + 2k] \quad (3.8)$$

$$\text{BIC} = [-2logL + \log(n)k] \quad (3.9)$$

where:
L : the likelihood function
k : the number of estimated parameters in the model
n : number of sample

AIC is an estimate of a constant plus the relative distance between the unknown true likelihood function of the data and the fitted likelihood function of the model, so that a lower AIC means a model is considered to be closer to the truth. BIC is an estimate of a function of the posterior probability of a model being true, under a certain Bayesian setup, so that a lower BIC means that a model is considered to be more likely to be the true model.

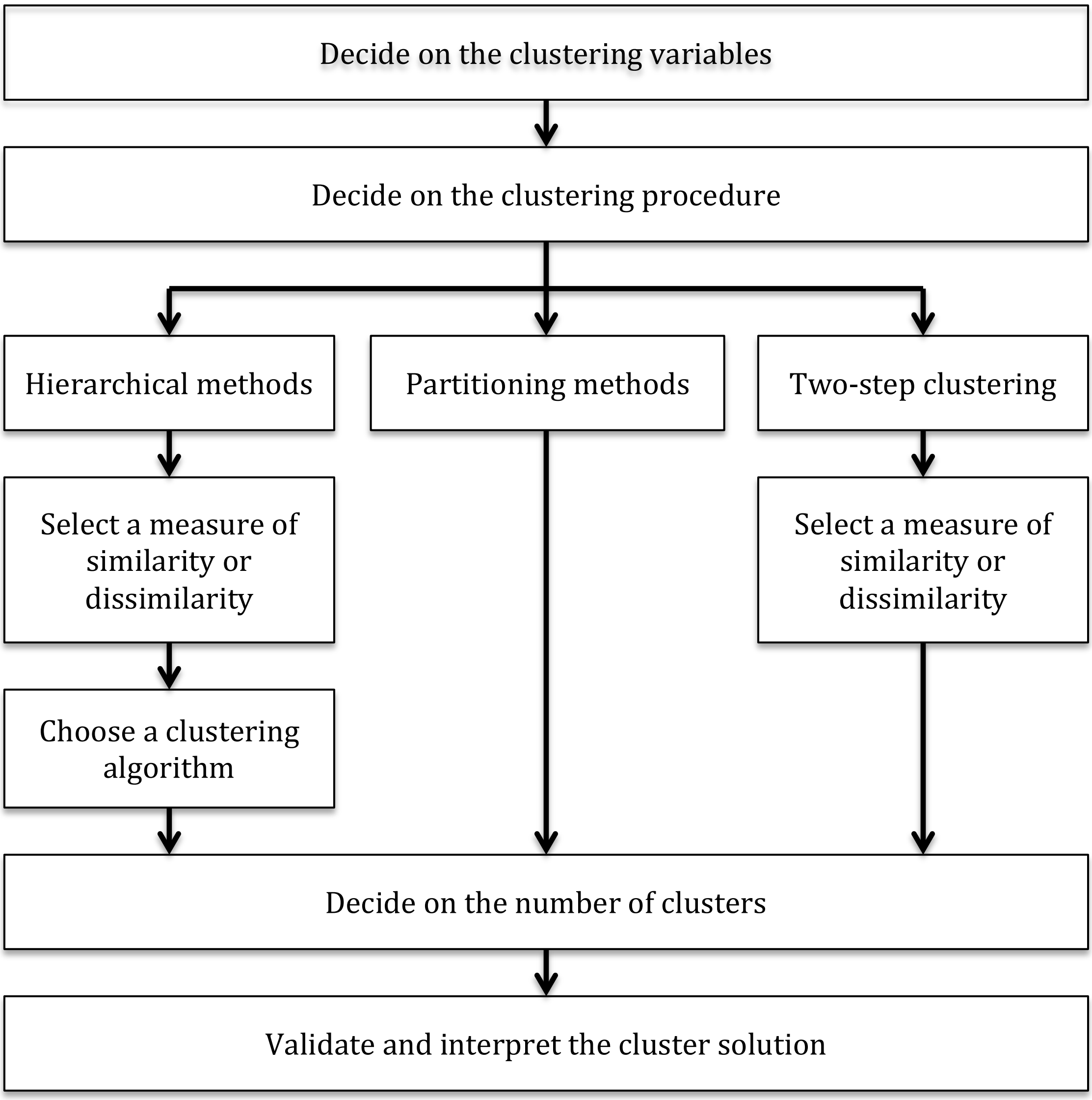



Figure 3.2 Steps in Cluster Analysis. Source: Mooi and Sarstedt (2011)

The cluster analysis has been used in many studies in travel behaviour research area such as Ryley (2006) and Anable (2005). Ryley (2006) applied the hierarchical cluster analysis to identify population segments based on socio-economic data and studied the travel behaviour of the each segments. Ryley (2006) found that the key life stages such as gaining employment, having children and retiring have a strong relationship with travel behaviour such as a high earning household is car dependent and retired living on own, students and in-between jobs are the lowest motor car availability. Anable (2005) studied travel behaviour of visitors at a conservation heritage where factor analysis and cluster analysis were used to classify the population into groups. First, Anable (2005) conducted factor analysis on multi-dimensional attitude statements and then applied cluster analysis to classify the factor score into several distinct groups.

According to Mooi and Sarstedt (2011), as shown in Figure 3.2, the steps in conducting cluster analysis are as follows:

1. *Clustering procedure*

   In this step, based on the characteristics of data, the most appropriate clustering method should be decided first. Table 3.5 shows the characteristics of each cluster analysis methods which available in the SPSS software used in this research.

2. *Numbers of sample and clustering variables*

   Generally there is no rule governing the number of samples accepted in cluster analysis. However, with reference to Table 3.5 no recommendation is made in Mooi and Sarstedt (2011) for Hierarchical and an ambiguous "*large data set*" is suggested for Two-Step, whilst for K-Means a sample >500 is specified. However Formann (1984) as cited by Mooi and Sarstedt (2011) suggested that at least $2^m$, where m equals the number of clustering variables are needed to gain statistical confidence.

3. *Number of clusters*

   Different clustering methods have different guidance in deciding the number of clusters. In the Hierarchical method, a large distance for an additional cluster combination indicates the number of clusters. Whilst in the K-Means method, the number of clusters are pre-defined and fixed by the researcher. The Two-step technique uses a measure of fit such as the Akaike' information criterion (AIC) or Bayes Information criterion (BIC), in order to decide on the number of clusters.

Table 3.5 Characteristics of different cluster analysis methods

| Features | Hierarchical cluster analysis | K-means cluster analysis | Two-step cluster analysis |
|---|---|---|---|
| Data Set | Metric, rating or ordinal data | Ordinal data | Ordinal and nominal data |
| Similarity measurement | Uses Euclidean or city-block distance[1] | Uses the within-cluster variation | Similar to k-means and then conducts a modified hierarchical agglomerative clustering procedure |
| Number of data required | Not specified | Sample size > 500 | Large data set |
| Clustering algorithm | First each object is represented as an individual cluster. Then sequentially merged based on their similarity. | Randomly assign objects to a number of clusters and then reassign the objects to other cluster to minimize the within-cluster variation until it is convergence. | First step is similar to the k-means where all data records are scanned and the dense regions of the records are stored in summary statistics, followed by second step: hierarchical agglomerative clustering procedure where each dense region is treated as an individual point. |
| Guidance in deciding number of clusters. | Very limited guidance in deciding number of clusters. The most meaningful indicator is the distance to an additional combination of clusters. | Number of clusters has to be specified. | Number of clusters decided from a measure of fit such as Akaike' information criterion (AIC) or Bayes Information criterion (BIC). |
| Advantages | - Dendogram shows the distance between the resulting classes.<br>- Can be used for different kinds of data (e.g. continuous, interval and nominal) | - Less affected by outliers<br>- Less computationally demanding. | - Can effectively cope with large datasets.<br>- Can handle continuous and categorical variables simultaneously.<br>- Flexibility in specifying number of clusters retained. |
| Disadvantages | - Not recommended for mix between nominal and ordinal data.<br>- Once an object is assigned to a cluster, it will stay in the cluster.<br>- Affected by outliers. | - May produce distortion when used on ordinal data.<br>- Has to pre-specify the number of clusters to retain. | - Better when dataset is large. |

Source: Adapted from Mooi and Sarstedt (2011) and Chiu *et al.* (2001)

[1] City-block distance uses the sum of the variable's absolute differences.

4. *Validation and interpretation*

The solution of the cluster analysis has to be examined according to its stability and validity. A solution is considered stable when the use of different clustering procedures on the same data yields statistically similar results. City block allows entities within the and with cluster to "*compensate each other*" whilst the Chebychev "*looks after*" or "*engaged*" the extreme values. The Euclidean distance method is more "*probabilistic*". In order to test for validity of the solution, there are some criteria suggested by Mooi and Sarstedt (2011, p. 261):

- Substantial: The segments are large and profitable enough to serve.
- Accessible: The segments can be effectively reached and served, which requires them to be characterized by means of observable variables.
- Differentiable: The segments can be distinguished conceptually and respond differently to different marketing-mix elements and programs.
- Actionable: Effective programs can be formulated to attract and serve the segments.
- Stable: Only segments that are stable over time can provide the necessary grounds for a successful marketing strategy.
- Parsimonious: To be managerially meaningful, only a small set of substantial clusters should be identified.
- Familiar: To ensure management acceptance, the segments composition should be comprehensible.
- Relevant: Segments should be relevant in respect of the company's competencies and objectives.
- Compactness: Segments exhibit a high degree of within-segment homogeneity and between-segment heterogeneity.
- Compatibility: Segmentation results meet other managerial functions' requirements.

Interpretation of the clusters is a challenging task where researchers examine the cluster centroids and make sure that each cluster exhibits significantly different and distinguishable characteristics from other clusters and also presents the objects in the cluster with a meaningful name or label. The label emerges from the characteristics of the majority populous of those allocated to specify cluster.

### *B. Data reduction using Factor Analysis*

Factor analysis has been used to reduce the number of variables in many social science studies and has been applied in several transportation studies, in particular (Ando and Aoshima, 1997; Suraji and Tjahjono, 2012; Wong and Choy, 2012; Syed and Khan, 2000). The purpose of factor analysis is to reduce the number of variables characteristics data by identifying factors that explain patterns of correlations within a set of observed variables. Those variables highly correlated with each other are grouped into a new variable called a factor (Mooi and Sarstedt, 2011). Table 3.6 shows various methods available in each step in the application of factor analysis technique.

There are two types of factor analysis i.e. exploratory and confirmatory. Statistically, both of the techniques are identical but are used for different purposes. The exploratory factor analysis is used to reveal the number of factors and the variables that belong to specific factors, whilst confirmatory factor analysis is used to test if expectation regarding the factor structure is indeed present. This section will only give a brief description of exploratory factor analysis, as it is more relevant to the purpose of this study.

Despite the existence of advantages and disadvantages of the different techniques, Osborne and Costello (2005) argued that principal components with varimax rotation and the Kaiser criterion do not yield optimal results. Therefore, they recommended the use of procedures of maximum likelihood in extraction methods, oblique in rotation, and screen plots plus multiple test runs. On the contrary, Mooi and Sarstedt (2011) suggested the use of principal components analysis when data reduction is the primary concern because it is believed to be less complicated although, it is said to yield very similar results to the others.

As researchers take a stand in different positions when choosing the most appropriate method (Fabrigar *et al.*, 1999; Osborne and Costello, 2005; Mooi and Sarstedt, 2011), the author adopted all available methods to reveal a greater understanding of the underlying methods. According to Mooi and Sarstedt (2011), the principal component analysis is based on correlations between items; therefore the items are preferable to be sufficiently correlated which is recommended to be above the absolute 0.30. A correlation matrix and an anti-image are used to determine whether the correlations are sufficient or not. Anti-image is a matrix that shows the proportion of an item's variance that is independent of another item in the analysis.

Table 3.6. Advantages and disadvantages of various methods of factor analysis

| Issue | Methods | Advantages | Disadvantages |
|---|---|---|---|
| Factor Extraction | Principal component analysis | - Principal component analysis is often the default method in popular statistics software such as SPSS and SAS.<br>- Suitable if the variables are highly correlated.<br>- More appropriate for data reduction. | - Cannot detect latent variables behind underlying structure.<br>- Does not discriminate between shared and unique variance. |
| | Principal axis factors | - Suitable if data are not normally distributed<br>- Less likely to produce improper solutions than Maximum likelihood. | - Do not allow for computational confidence interval and significance test. |
| | Maximum likelihood | - Suitable if data normally distributed (it is allows statistical test). | - Can produce distorted results when the data is not normally distributed. |
| Number of factors retained | Eigenvalues | - Available in software. | The least accurate methods |
| | Monte Carlo analysis | | Retains too many factors |
| | Scree test | Frequently used and available in software | Unclear if there are data points clustered together near the bend. |
| | Velicer's MAP criteria and parallel analysis | Claimed to be more accurate and easy to use. | Not available in software |
| Rotation | Orthogonal: varimax, quartimax, equamax. | - Produce factors that are uncorrelated.<br>- Commonly recommended because it is easily interpreted.<br>- Varimax is the most common rotation used. | - Loss of information when the factors are correlated. |
| | Oblique: direct oblimin, quartimin, promax. | - Correlated factors are allowed.<br>- Claimed to be more optimal and more reproducible.<br>- Reproduce an orthogonal solution. | - The output is more complex than orthogonal because the pattern matrix need to examine for factor loading and correlations between factors revealed from the factor correlation matrix. |

Source: Summarised from Osborne and Costello (2005) and Fabrigar *et al.* (1999)

Table 3.7 KMO threshold values

| KMO/ MSA value | Adequacy of the correlations |
|---|---|
| Below 0.50 | Unacceptable |
| 0.50-0.59 | Miserable |
| 0.60-0.69 | Mediocre |
| 0.70-0.79 | Middling |
| 0.80-0.89 | Meritorious |
| 0.90 and higher | Marvellous |

Source: Mooi and Sarstedt (2011)

Table. 3.8 Steps in conducting factor analysis

| No. | Steps | Advice/ Recommendation |
|---|---|---|
| 1 | Check assumption and carry out preliminary analysis. | - Make sure the sample size is sufficient.<br>- Exclude missing values.<br>- Correlations between items are above absolute 0.30.<br>- Correlations matrices are as high as possible.<br>- Anti-mage matrices are as low as possible. |
| 2 | Extract the factors. | - Extracted factors account for at least 30% of all variables' variance. |
| 3 | Determine the number of factors. | - Eigen value describes how much variance is accounted for by each factor.<br>- Extract all factors that have an eigenvalue greater than one.<br>- Scree plot typically showing a distinct break called "elbow" as an indicator in deciding number of extracted factors.<br>- Choose one factor less than that indicated by the elbow to retain all factors above the break as they contribute most to the explanation of the variance of the data set. |
| 4 | Interpret the factor solution. | - Create a subjective labelling of extracted factors that describe the joint meaning of the variables.<br>- Factor rotations ensure particular variables belong to particular factor that facilitate the interpretation. |
| 5 | Evaluate the goodness-of-fit of the factor solution using validity measures | - Assess using the difference between the correlations in the data and those implied by the factors.<br>- Absolute value of the proportion of the correlation matrices' residual is required to be as small as possible.<br>- Raise concern if the proportion of absolute values that are higher than 0.05 is higher than 50%.<br>- Each variable's communality should be as high as possible. |

Source: Summarised from Mooi and Sarstedt (2011)

All items are highly correlated when the items' anti images are small. The interpretation of the anti-image matrices revert to the Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) statistic (also known as measure of sampling adequacy or MSA) as shown in Table 3.7. The Bartlett's test of sphericity examines the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and therefore, unsuitable for structure detection, whilst the KMO is a statistic that indicates the proportion of variance in the variance that might be caused by underlying factors.

Steps involved in Factor Analysis are shown in Table 3.8 as suggested by Mooi and Sarstedt (2011). Regarding the number of samples, Preacher and MacCallum (2002) noted that as long as communalities are high, the number of expected factors is relatively small and the model error is low (a condition which often goes hand-in-hand with high communalities), researchers and reviewers should not be overly concerned about small sample sizes. However, as exploratory factor analysis is known as a "*large-sample*" procedure, Osborne and Costello (2005) suggested using more samples. Therefore the technique of factor analysis should reconsider the assumptions and reflect again on the results to ensure the validity.

*C. Importance-Satisfaction Analysis*

The Importance-Satisfaction Analysis (ISA) is an extension of The Importance-Performance Analysis (IPA) tool employed to evaluate the priority among several issues, based on the preferences of the consumer. The analysis can be used to establish the degree of impact on consumer satisfaction against the level of importance of an intervention (Martilla and James, 1977; Graf *et al.*, 1992).

The ISA (or IPA) has been previously applied in many research areas such as tourism (Sorensson and Friedrichs, 2013; Coghlan, 2012; Tonge and Moore, 2007; Arabatzis and Grigoroudis, 2010), bank services, industry (Lo *et al.*, 2012; Matzler *et al.*, 2004; Hu *et al.*, 2009), and education (Wang and Tseng, 2011; Lewis, 2004). The method was also applicable in the research of public transport such as in Yahya and Bell (2011), Freitas (2013), and Thompson and Schofield (2007). In rail transportation research, Chow *et al.* (2011) employed the ISA to understand passengers' perceptions of the high-speed rail performance in Taiwan and Korea to be able to identify the top-priority quality that needed to be addressed to improve customer satisfaction.

The first step in carrying out ISA is to generate a list of attributes of the services that are relevant to the objective of the study. The second step is to collect data where respondents are asked to rate on the Likert-scale, the degree of the importance and their satisfaction with each of the attributes. According to Martilla and James (1977), a five- or seven-point scale will yield a good spread of ratings. The third step is to calculate the central tendency of the rating for each attribute. Theoretically, median values are more preferable, however, Martilla and James (1977) argue that both the median and mean values can be used because referring to Martilla and Carvey (1975), minor violations of the interval scale assumption are not considered to be serious, especially when the mean and median values are consistently appear reasonably close. The fourth step is to plot the central tendency values on a four quadrants separated by a cross hair line as shown in Figure 3.3 as proposed by Graf *et al.* (1992) and Martilla and James (1977).

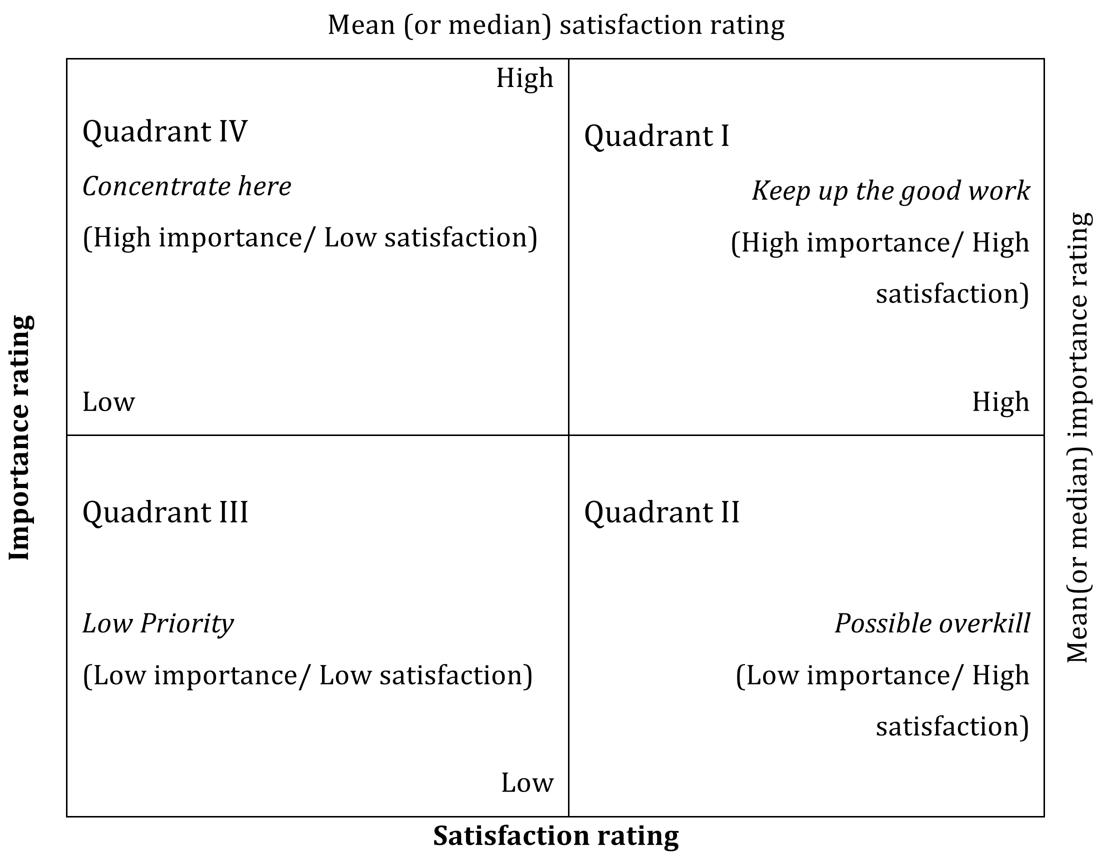



Figure 3.3 Importance-satisfaction assessment matric (Graf *et al.*, 1992)

The graph is two-dimensional where the importance scale represents the vertical axis and the satisfaction scale constitutes the horizontal axis. Attributes residing in the first quadrant (top right) exhibit those attributes with high importance and high satisfaction as perceived by the consumer. For these attributes, level of service provision or response to consumer issues should continue to be maintained and thus labelled "*keep up the good work*". Attributes in the second quadrant are those attributes considered to have a lower level of importance and a higher level of satisfaction. These attributes are exceeding expectations and could be considered potentially "*overkill*".

However as reported by Yahya and Bell (2011) on a study of Quality Bus Partnership (QBP) it may be that these distributes fall in this quadrant because expectation is met and therefore, customers are satisfied. Or that the reason why these attributes are considered as lower importance is because of item high satisfaction. Therefore it follows that a lapse in service quality may result in a shift into either quadrant III or IV. The attributes in the third quadrant are considered of lower importance and lower satisfaction. These attributes are less important and less satisfied and labelled a "*low priority*". In the last quadrant attributes have a higher level of importance and lower level of satisfaction and labelled as "*concentrate here*", suggesting that to obtain maximum benefit from expenditure of resources and/or managerial attention, items in this quadrant should be given top priority in any intervention effort. However, Graf *et al.* (1992) notified that the one intervention might positively impact more than one item at any quadrant.

The most commonly used approach in defining the cut-off points to establish the four quadrants found from the previous studies was using the grand means of all attributes such as in Graf *et al.* (1992); Lo *et al.* (2012); Sorensson and Friedrichs (2013). Another study used of the mid-point of the Likert-scale (e.g. three for a five point scale) and the mid-point of the observed data (e.g. four when data spread between three and five) as a cross-hair line such as Lewis (2004). Oh (2001) carried out a critical review on the use of actual means and mid-point of Likert-scale as the cross-hair point in several studies and concluded that the use of the mid-point of the Likert-scale is when attempting to compare the importance to the performance. However, when attempting to conduct a relative interpretation of attributes within importance and performance, the actual means was recommended.

An inconsistency was found in previous studies where Graf *et al.* (1992); Lo *et al.* (2012); Sorensson and Friedrichs (2013); Freitas (2013); Chou *et al.* (2011); Wang and Tseng (2011); Coghlan (2012); Tonge and Moore (2007); and Hu *et al.* (2009) put the importance scale on the vertical axis and the satisfaction on the horizontal axis, whilst Arabatzis and Grigoroudis (2010); Matzler *et al.* (2004); and Yahya and Bell (2011) put the importance scale on the horizontal axis and the performance scale on the vertical axis. However, the different in assigning the scale on the axis did not influences the interpretation of the results.

In this study, the Importance-Satisfaction Analysis was used to investigate respondents' opinions about several variables related to train services in the information and communication era.

## 3.4 Research on VOT

### *3.4.1 General*

Several VOT studies were reviewed in Chapter 2. The VOT studies are based on the assumption that people make choices by considering trade-off between time and money (De Borger and Fosgerau, 2008). Some people will pay more to arrive earlier at the destination and some people accept longer journeys and arrive later, in order to save money. A counter-intuitive finding where people would pay for a longer journey also was found in some studies (Hess *et al.*, 2005). The research suggested that alternative choices by people were influenced by the 'situations' in which the respondents found themselves when the decision was made. Situations in this context refer to the variability of the values assigned to each of the attributes considered, namely fares, travel time, mode availability and activities that can be conducted whilst travelling.

As this presented study investigates the relationship between the perceived and actual travel time, activities conducted whilst travelling as well as the value of travel time. The conventional value of travel time theory was adopted. This will be explained in the following section.

### *3.4.2 Data collection methods*

Based on the situation presented, choice data can be differentiated into two categories that are revealed preference (RP) and stated preference (SP). In RP data, the choice is the actual one made in the real situation (real alternatives with attributes and levels). In SP data, the choice is made based on hypothetical situations (attributes may be the same as RP, but given at different levels). Most often, SP is used to observe the effect of a new alternative added into a system. However, in some studies a combination between RP and SP in a choice model is also possible and has been applied in studies of travel behaviour such as Dissanayake and Morikawa (2010); Espino *et al.* (2006); and Train and Wilson (2009).

There are limitations in RP data collections discussed in Ortuzar and Willumsen (2011), that include the fact that the actual choice may not provide sufficient variability for constructing good models, a few factors may dominate the model and more challenging is collecting data to inform a new policies because the actual choice has not been made. On the other hand the SP method has the advantage that it uses hypothetical settings to obtain respondent's preferences toward a new policy so that the impact of the policy can be detected and anticipated earlier. Certainly SP techniques have tended to dominate value of travel time studies including Toner (1991); Ramjerdi (1995); Algers *et al.* (1996); Gunn *et al.* (1999); Mackie *et al.* (2003); Steimetz and Brownstone (2005); and Axhausen *et al.* (2008), all of whom have used and discussed a wide range of studies. Toner (1991) used SP technique to investigate the value of time of taxi users whilst Ramjerdi (1995); Algers *et al.* (1996); Gunn et al (1999); Mackie *et al.* (2003) and Axhausen *et al.* (2008) studied VOT in Norway, Sweden, Netherland, UK and Switzerland respectively. On the other hand Steimetz and Brownstone (2005) specifically studied the VOT of commuters.

In Stated Choice Experiments (SCE), a kind of Stated Preference (SP) Surveys, the respondents express their preferences by choosing one of available alternatives. In the earliest stated choice experiments paper and pencil were used, but nowadays much use is now made off the Internet, which is becoming most popular.

Bliemer and Rose (2006) suggests 3 steps are involved in creating stated choice experiments

a. Specifying a Model

The first step is to design the SCE. In specifying the model, researchers need to decide what alternatives will be examined, what attributes should be included as variables for each of the alternatives and whether the parameters are generic or alternative-specific.

Then the researcher chooses the type of model. The three most common models employed include the Multinomial Logit Model, Nested Logit Model and the Mixed Logit Model.

b. Generate experimental design

In generating the experimental design, the number and range (or levels) for each attribute should be decided upon first. The attribute level is level of value of attributes that will be combined in a questionnaire before being offered to respondents. For example, the attribute travel cost could be set at three levels: increased £10 (high level), increased £5 medium and increased £0 (low). The number and level of attributes should be carefully considered as the higher number and the more levels of attribute, the more complicated its combination and the more difficult the questionnaire is to be completed by respondents. Next the Experimental design is generated through combining attribute levels into a number of examined choice situations.

c. Construct questionnaire

The form of the questionnaire constructed from the combination of attributes level in the experimental design. In practice, the questionnaire form is usually offered to respondents using paper and pencil, computer aided, or Internet surveys.

A wide range of technical and practical issues related to the Stated Preference techniques can be learnt from Louviere *et al.* (2000), Hensher (2006) Sanko *et al.* (2002) and (Graf *et al.*, 1992), Rose and Bliemer, (2008), Hensher *et al.* (2005).

### *3.4.3 Methods applicable for data analysis*

There are several steps involved in the stated preference technique. The first is problem refinement; followed by alternatives and attributes identification, experimental design, construct survey instrument, data collection and finally data analysis and interpretation. Alternatives are the mutually exclusive available choice to choose for example bus or train, whilst attributes are measurable (or using the number in scaling to quantify personal judgement) particular features of the alternative such as cost and travel time (Nunnally and Bernstein, 1994). This section specifically discusses data analysis and interpretation and how results are used to identify the effects on the value of travel time of activities carried out during travelling.

The SP data is usually analysed using Multinomial Logit (MNL) Model. This model uses a utility function to represent the relationship between attributes associated with the alternatives presented in the SP technique.

According to Louviere *et al.* (2000), the probability of individual $q$ choosing alternative $i$ can be written as:

$$P_{iq} = \exp(V_{iq}) / \sum_{j=1}^{J} \exp(V_{jq}) \quad \text{……………………………………………. (3.10)}$$

Where:

$P_{iq}$ = Probability of individual $q$ choosing alternative i.
$V_{jq}$ = The utility of the $j$th alternative.
$V_{jq}$ is assumed to be linear and can be written as:

$$V_{jq} = \sum_{k=1}^{K} \beta_{jk} X_{jkq} \quad \text{………………………………………………………… (3.11)}$$

Where:

$\beta_{jk}$ = The utility parameter of attribute $X_k$
$X_{jkq}$ = The $k$th attribute of the $j$th alternative of individual $q$.

When two alternatives, namely Train and Car, are available to choose from by considering the cost and travel time of each alternative, the utility expressions $U_{train}$ and $U_{car}$ respectively are:

$$U_{train} = \beta_0 + \beta_{ctrain}(Cost_{train}) + \beta_{ttrain}(Time_{train}) \quad \text{…………………… (3.12)}$$

$$U_{car} = \beta_{ccar}(Cost_{car}) + \beta_{tcar}(Time_{car}) \quad \text{……………………………………. (3.13)}$$

Where:

$\beta_0$ = constant
$\beta_{ctrain}$ and $\beta_{ccar}$ = parameter of variable cost for train and car respectively
$\beta_{ttrain}$ and $\beta_{tcar}$ = parameter of variable time for train and car respectively

Please note that an alternative specific constant is excluded for an arbitrary alternative to be able to solve the equation. However, when the alternatives are "*unlabelled*" (which means the label of alternatives do not provide any useful information to suggest that there are unobserved factors influencing the quality and therefore the parameter should be treated as generic.), no alternative specific constants are allowed in the model (Hensher *et al.*, 2005). The marginal rate of substitution between travel time and cost can be calculated as a ratio of the travel time utility parameter and the travel cost utility parameter, which is well known as the value of travel time saving (VTTS) is estimated using the equation:

$$VTTS_j = \frac{\beta_{tj}}{\beta_{cj}} \quad (3.14)$$

where:

$VTTS_j$ = Value of travel time saving for alternative $j$.

$\beta_{tj}$ = The travel time utility parameter of alternative $j$.

$\beta_{cj}$ = = The travel cost utility parameter of alternative $j$.

The SP techniques and MNL in attempting to investigate the VOT or VTTS have been widely used and have proven to produce reasonable results as discussed in the previous sections, and therefore, will be adopted in this study.

## 3.5 Summary

The data collection and analysis methods that have been used in previous research have been reviewed in this chapter, including studies of the perception of time, travel time experiences and value of travel time.

In assessing the perception of time whilst travelling, both laboratory exercises with fully controlled stimulus and in a real situation have been discussed. The laboratory experimental approach has the advantage that the stimulus is precisely defined and repeatable, and unnecessary stimulus can be omitted, however the exhibited behaviour may contain bias as the participants have been conditioned prior to the examination. The second approach where respondents were approached in a real-life situation was used in assessing the perception of travel time by Wilson (1983) and waiting time at a bus stop by Mishalani *et al.* (2006). Data from both studies were analysed using linear regression analysis demonstrating the appropriateness of this technique to derive a perceived and actual travel time.

Several methods used to collect data concerning opinions, attitudes and experiences of participants toward transportation services have been discussed including the self-completion questionnaire, interview, structured observation, focus groups, and ethnography. Each of the methods has advantages and disadvantages. However, given the objective of this study is to investigate whether the attitudes and the perception of travel time affect each other, it is more appropriate to use the interview technique of whilst travelling. The interview whilst travelling approach offers the advantage of reporting activities, opinions and attitudes based on the real time experiences.

The opinions and attitudes of respondents were established using the Likert-scale technique consistent with and common to the attitudinal survey. A Likert rating of seven was chosen as it provided sufficient point discrimination of individual perceptions and previous studies suggested that the results were not significantly different from using a more fine scale such as 11. Cluster analysis and factor analysis were the most common methods applied to the attitudinal data. The choice of a specific technique in cluster and factor analysis depends on the data types. In this study a multifaceted approach to the analysis which factor, cluster and ISA, were used together.

Finally, several methods in the VOT studies were briefly reviewed including RP, SP and combination of RP and SP techniques. The studies showed that the SP techniques were more popular and have been used increasingly in recent studies. In analysing the SP data, there were several models available such as Multinomial Logit model (MNL), Nested Logit model and Mixed Logit model. Given the data used to estimate the VOT was produced from an unlabelled choice experiment, the MNL model was chosen as the most appropriate method to achieve the objective.

Based on the methodological review in this chapter, a methodological framework which integrates several methods such as linear regression, cluster analysis and factor analysis as well as the MNL have been developed to achieve the study objectives. This will be presented in the next chapter.

# Chapter 4: Methodological Framework

## 4.1 Introduction

A critical review of perception of time, productive use of travel time, attitudes towards train service and value of travel time was presented in the Chapter 3. In this chapter, the discussion initiated in Chapter 3 continues in the context of their use in this research to investigate the influence of technology on the perception of travel time. Therefore, this chapter addresses the 1$^{st}$ objective of the study namely "*to conduct a critical review on previous studies of travel behaviour of public transport users especially related to perception, attitude and the value of travel time to be able to explore the gap of knowledge and to set up a structured methodological framework to fill the gap*" and develop appropriate procedures for data collection and analysis, and interpretation of the results. The chapter consists of 11 sections. Section 4.2 presents the framework of the methodology showing the steps involved; Sections 4.3 to 4.9 describe the steps commencing with the data collection, followed by an explanation of each analytical method and interpretation of the results; Section 4.10 describes the case study and finally, an overview of this chapter is presented in Section 4.11.

## 4.2 Methodological Framework

In order to achieve the objectives and to examine the hypotheses of this study, a framework for the methodology was developed as shown in Figure 4.1. For clarity the components of the methodology was mapped into the chapters of the reminder of the thesis.

In order to investigate the role of technology in influencing the perception of time, an integrated approach of collecting both qualitative and quantitative primary data was adopted in this study. Four groups of data resulted from the surveys namely: 1) perceived and the actual travel time, 2) personal characteristics (socioeconomic characteristics and the journey specific characteristics of respondents), 3) the attitudinal data, and 4) the Stated Preference (SP) data to estimate the value of time.

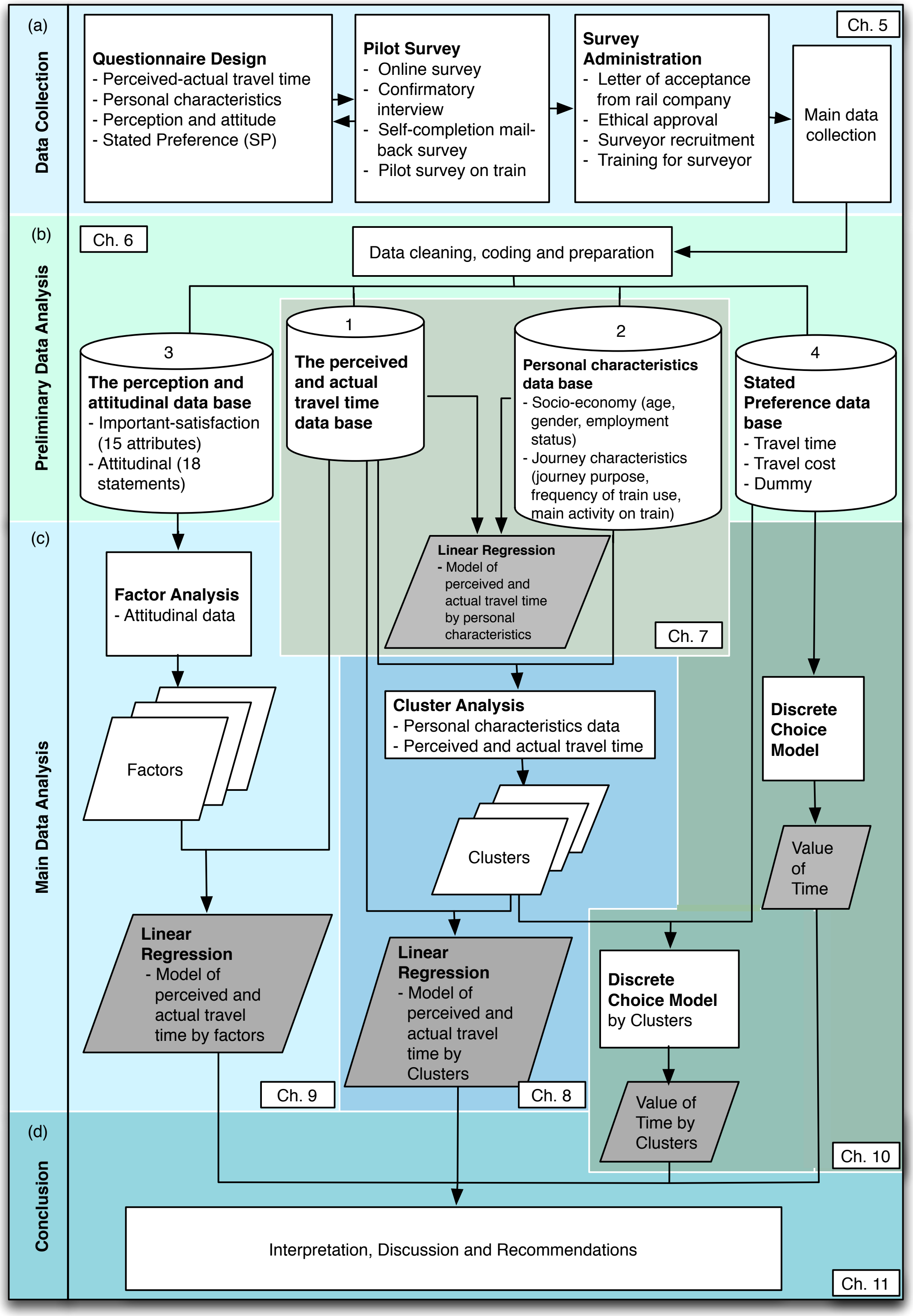



Figure 4.1 Methodological framework

In the framework, these were analysed separately, and then combined together to obtain a deeper understanding of the problem. The analyses included the investigation of the relationships between perceived and actual travel time and further investigation to learn how the relationship is affected by factors of personal characteristics. Further, relationship between the perception, attitude and the value of travel time was investigated. Each of steps will be explained in more detail in the following sections.

### 4.3 Data Collection

Rather than using the self-completion questionnaire by recollection of a recent journey, as used in most of travel time studies, this study collected data by interviewing passengers whilst travelling by train. The author considers a self-completion questionnaire was not an appropriate method to study the perception of time, as the perception could change for example before, during and after the journey. However, most of the questions in the self-completion questionnaire such as passengers' activities in Passenger Focus (2009) and attitudes whilst travelling in Ettema and Verschuren (2007) and Dawes (2002) can be adapted in this study. Therefore, the questionnaire design and data collection methods for this study were a combination of the methods applied in Wilson (1983), Passenger Focus (2009), Ettema and Verschuren (2007) and Dawes (2002). By interviewing passengers whilst travelling, there was an opportunity to gain a better understanding of how people perceived the travel time for the duration of the trip up to the specific point in the journey the interview took place. Such data would be difficult to obtain from self-completion questionnaires before or after making a journey.

The process of data collection was started by designing a questionnaire, followed by gaining approval from the university ethics committee and securing a letter of acceptance from the train company to gain access to train passengers. Before conducting the pilot survey, the questionnaire was tested through 1) an online survey, 2) a phone interview and 3) a mail-back questionnaire survey. Recruiting and giving training to surveyors took place before conducting the main survey. In order to make sure all issues were well addressed in the questionnaire before the main survey took place, a one-day pilot survey was conducted. The main survey was conducted for seven days during mid July 2011. Details of each stage of the data collection process are elaborated upon in Chapter 5.

### 4.4 Preliminary Analysis

Before being analysed, the data was cleaned, coded and prepared in the appropriate format for the available software used in this study, including IBM-SPSS version 17, Minitab version 16 and NLogit version 4.0.

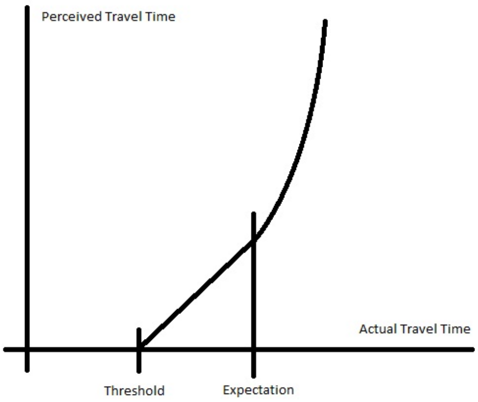
A descriptive statistics analysis was conducted to establish the sample characteristics, distribution and the relevant issues and concerns of the data. The outcome was important to gain a fundamental understanding of the limitation of the data and the results of the study.  The initial descriptive analysis includes derivation distribution of data including mean, mode, median, standard deviation and variance as well as tables, graphs and charts to visualise the statistical properties of the data. The results of the descriptive analysis are discussed in Chapter 6.

### 4.5 Relationship between Perceived and Actual Time

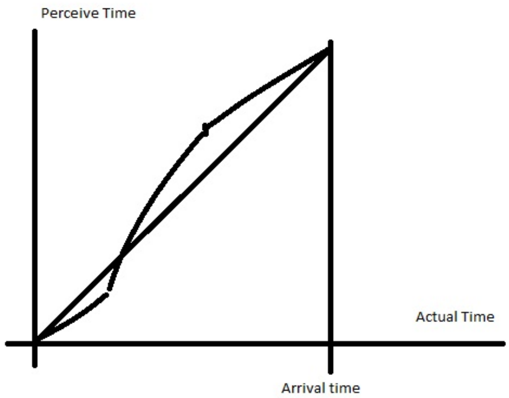
In order to investigate the perception of travel time on a train, a relationship between perceived and actual travel time was taken in to consideration. Some models used in literature such as Bell, 1976; Wilson, 1983; Mishalani *et al.*, 2006 have been reviewed in Chapter 3. The studies assumed the relationship between the perceived and the actual time is linear. However, the probability to have a non-linear relationship should not be ignored as previous studies revealed that the perceived time might not be equal to the actual (Wilson, 1980; Danckert and Allman, 2005; Mishalani *et al.*, 2006).

The relationship of perceived and actual time depends on the distribution of data plotted as a scatter gram. The relationship may be linear, non-linear or a combination of linear and non-linear as shown in Figure 4.2.

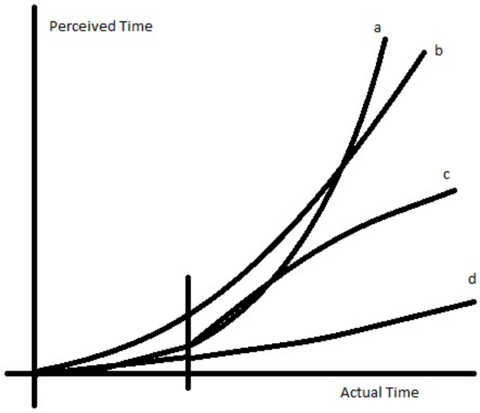
As illustrated in Figure 4.2 (a.) there is a threshold where a small amount of time is perceived as zero or not perceived at all by passengers. After the threshold is reached, the perceived travel time slowly increases until it is equal to when the actual time reaches the expected (time tabled) arrival time. However, if the train is delayed and the expected arrival time has been passed, therefore the perceived time may increase sharply. The increase in perceived time when the expected arrival time has passed was discussed by Mishalani *et al.* (2006).




(a.) Travel time perceived higher than actual when the timetabled arrival time has been passed.




(b.) The perceived travel time decreases and then increases and finally decreases again on the arrival time.




(c.) Perceived and actual time by different groups of people

Figure 4.2 Hypothesised relationships between perceived and actual travel time

Figure 4.2 (b.) shows the perceived time lower than the actual until a threshold is reached, then the perceived time changes depending on the activities and attitude of the passengers until a second threshold where the perceived time is close to the actual at the end of the journey. As an illustration, as soon as a passenger boards a train, the passenger needs to set up everything to make his/her journey comfortable. During this time, the traveller will not be aware of the time so that the perceived time tends to be lower than the actual. During the journey, the perceived time will increase or decrease depending on the comfort of the seat, their activities, and other variables. At a particular time before reaching the destination, the perceived time may become approximately equal to or possibly less than the actual, as the passenger is excited about the activity he/she will conduct at the destination (especially if the passenger is aware of the expected time of arrival at the destination and no delay has occurred in the journey).

Figure 4.2 (c.) illustrates potential relationships between the perceived and actual time given the availability of technologies depending on the characteristics of groups of travellers with different perceptions of time. In this case, a different model needs to be developed for each group.

In this context, the perceived travel time is a function of actual travel time and other characteristics of respondents and the journey, such as age, income, gender, technology used, activities, and journey purpose. Such a model will take the following form:

$T' = f(T, CR, CJ, RX)$ …………..……………………………………………….. (4.1)

Where:

$T'$ = perceived travel time

$T$ = actual travel time,

$CR$ = characteristic of respondent,

$CJ$ = characteristic specific of the journey, and

$RX$ = respondent experience/activity whilst travelling.

### 4.6 Cluster Analysis

Cluster analysis was used to investigate the structure of the data and to segregate respondents based on similar characteristics. As described in Chapter 3, the steps in cluster analysis are as follows (Mooi and Sarstedt, 2011):

A. Identify variables
B. Select clustering procedure
C. Decide the number of clusters
D. Validate and interpret the clustering solution

### *4.6.1 Identifying variables*

The cluster analysis in this study was implemented considering personal characteristics such as socioeconomic data (age, employment status and gender) and journey specific characteristics data (journey purposes, frequency of train use and main activity on the journey). In order to make a connection to the perception of time; data of actual and perceived travel time were included. There were eight variables in total, used in the cluster analysis i.e.:

- Age
- Employment status
- Gender
- Journey purpose
- Frequency of train use
- Main activity whilst travelling
- Perceived travel time
- Actual travel time

### *4.6.2 Selecting clustering procedure*

In deciding the clustering procedure, it is important to examine the type of variables involved. In this analysis, variables of age, frequency of train use, actual and perceived travel times were ordinal data and variables of employment status, gender, journey purposes and main activity whilst travelling were categorical data. According to Mooi and Sarstedt (2011), the best clustering procedure to analyse both ordinal and categorical data is the two-step cluster analysis. The two-step cluster analysis allows the researcher to use both continuous and categorical data.

### *4.6.3 Deciding the number of clusters*

In the two steps cluster analysis, the number of clusters is decided upon from a measure of fit criterion such as Akaike's information criterion (AIC) or Bayes Information criterion (BIC) as described in Chapter 3.

### *4.6.4 Validating and interpreting the cluster solutions*

The solution of the cluster analysis was examined for stability and validity. A solution is considered stable when the applications of different clustering procedures on the same data yield statistically similar results (Mooi and Sarstedt, 2011).

### *4.6.5 Regression analysis between perceived and actual travel time by clusters*

At the end of the steps in the cluster analysis, the relationship between the actual and perceived travel time was illustrated for each cluster by means of graphs. A statistical test (t-test and F-test) was applied to compare the fitted model results of each cluster and thus to establish whether the perception of travel time differs from or is similar to other groups with different characteristics.

## 4.7 Factor Analysis

Factor analysis was used to reduce the dimensions of the data by identifying factors that explain patterns or correlations within a set of observed variables (Mooi and Sarstedt, 2011).

In this study, there were 18 statements related to respondent's attitudes that were examined. These were:

1. I worry about my personal safety when I travel by train.
2. Travelling by train makes me nervous.
3. Travelling by train is tiring.
4. I sometimes feel unwell when travelling by train.
5. I sometimes feel uncomfortable being around people I don't know on the train.
6. I do not like to juggle several activities at the same time.
7. People should not try to do many things at once.
8. When I am at my office desk, I work on one project at a time.
9. I am comfortable doing several things at the same time.
10. The journey seems to pass more quickly when I am using my personal electronic devices, such as a laptop or iPhone.

11. Delays are less frustrating when free Wi-Fi is available on board
12. A small increase in travel time would be acceptable as long as free Wi-Fi is available on-board.
13. A small increase in the cost of the ticket would be acceptable as long as free Wi-Fi is available on-board.
14. This train is comfortable.
15. I would encourage people to use this train service.
16. I have the opportunity to work during my journey today.
17. Working on the train is more productive than in the office.
18. The duration of this journey is too long.

From the factor analysis, several factors were extracted based on the factor score as discussed in Chapter 3. In order to examine the effects of attitude to the perception of time, the relationship between the factor score of each extracted factors and the ratio of perceived and actual travel time was developed. Detail of this analysis will be discussed in Chapter 9.

Before starting the factor analysis, it is recommended that missing values be excluded and the sample size is sufficient. However, to replace the missing data, SPSS provides techniques to deal with missing values such as using series mean, mean of nearby point, median nearby point, linear interpolation, and linear trend at point. However, the use of the mean might increase the frequency of particular interval (the interval which contains the mean). The use of either mean or median of nearby point, linier trend at point and linear interpolation on the other hand were considered to be less rationally accepted as the resulting value would be dependent on the nearby point.

In this study, the technique random value generation by Discrete Monte Carlo Simulation was used. Using this technique, the replacement of the missing value was generated randomly and as much as possible maintains the distribution of data where the probabilities to obtain data lies in a particular interval is proportionate to the frequency of the interval.

In turn, missing values were generated based on selecting a value from the sample data of the same question. Steps in completing the missing data using the Monte Carlo Simulation are as follows:

1. Calculate the proportion of respondents' rating defines by the available data in answer to the question.
2. Plot the distribution providing values of Yi for each Xi where Xi is class interval i and Yi is the proportion of data that lay in Xi.
3. Generate two random numbers to provide x and y.
4. Accept the x if the y value is ≤ Yi and exclude if y > Yi.
5. Use the sample plus simulated data to check that the total distribution is not statistically significantly different from that in step 2. This provides a test in the procedure.

**4.8 Discrete Choice Model**

Discrete choice modelling was used to analyse the SP data. More specifically in this study the Multinomial Logit (MNL) model was chosen to allow multiple choices. In this study, respondents were offered three options namely *Same*, *More Cost Less Travel Time (MCLT)* and *Less Cost More Time (LCMT)*. TheS*ame* was an option where travel time and cost were not changed over the journey being made at the time the survey was conducted. The other two alternatives were hypothetical where the travel time and cost were changed by a fixed proportion of the current journey.

Therefore given that there are three alternatives in the questionnaire with two variables i.e. travel time and travel cost, the utility equation is given by:

$$U_i = \beta_{0i} + \beta_{ti}(Time) + \beta_{ci}(Cost) \quad (4.2)$$

Where:

$U_i$ = Utility of the option *i* by individual

$\beta_{0i}$ = Constant (parameter not associated with observed attribute of alternative *i*).

$\beta_{ti}$ = Parameter associated with attribute *Time* of alternative *i*

$\beta_{ci}$ = Parameter associated with attribute *Cost* of alternative *i*

$Time$ = Travel time

$Cost$ = Travel cost

Therefore, the utility model for each alternative would be:

$$U_{same} = \beta_{0same} + \beta_{tsame}(Time) + \beta_{csame}(Cost) \quad (4.3)$$

$$U_{MCLT} = \beta_{0MCLT} + \beta_{tMCLT}(Time) + \beta_{cMCLT}(Cost) \quad (4.4)$$

$$U_{LCMT} = \beta_{0LCMT} + \beta_{tLCMT}(Time) + \beta_{cLCMT}(Cost) \quad (4.5)$$

However, the options do not refer to any specific brand and do not provide any useful information to suggest that there are unobserved factors influencing the quality; therefore, the parameter should be treated as generic. A parameter is considered as generic when it is shared among all alternatives or in other words it is not specific to a particular alternative. Hensher *et al.* (2005) refer the case as an "*unlabelled-choice experiment*". The estimation of the constant terms of the alternatives within an unlabelled experiment is only possible when one of the constants is set to zero. However, when one of the constants is set to zero and the other constants were estimated, the constants were treated as alternative-specific constants. According to Hensher *et al.* (2005), it does not make sense to include any constant in a model for an unlabelled experiment, as the inclusion of alternative-specific constants would violate the meaning of "*unlabelled*". Therefore, the model for this study would be:

$$U = \beta_t(Time) + \beta_c(Cost) \quad (4.6)$$

Where:

$U$ : Utility
$\beta_t$ : Parameter associated with attribute *Time*
$\beta_c$ : Parameter associated with attribute *Cost*
*Time* : Travel time
*Cost* : Travel cost

VOT was estimated from the ratio between the parameter model of attributes travel time and travel cost as discussed in Chapter 3. VOT was derived for the total sample and then separately for each clusters resulting from the cluster analysis.

It is useful to compare the VOT found in this study with those of previous studies, although they cannot be compared directly because the methods and classification of the data were different. The comparison was carried out by adjusting the VOT in the previous studies to the quarter 3 2011 price when this study was carried out, as shown in Table 4.1. The quarter 3 2011 price for Wardman (2004) and Tapley (2008) were calculated as a multiplication of the VOT of those studies by ratio of consumer price index (CPI) of quarter 3 2011 and the CPI at the *considering* time of the VOT in those studies. For example, the VOT for commuter in Wardman (2004) was £12.60/hour at the quarter 3 2000 price; given the CPI on quarter 3 2000 was 170.9 and quarter 3 2011 was 236.2, the ratio of CPI quarter 3 2011 and quarter 3 2000 is 1.36; therefore the quarter 3 2011 price for commuter in Wardman (2004) is equal to £12.60/hour multiplied by 1.36 therefore equal to £17.14/hour.

Table 4.1 Conversion of VOT from previous studies to 2011 price

| **Study** | **VOT** | **Price Year** | **Quarter 3 2011 price** | **Note** |
|---|---|---|---|---|
| Wardman (2004) | 21p/min (£12.60/hr) | Quarter 3 2000 | 29p/min (£17.14/hr) | Commuting |
| | 22p/min (£13.30/hr) | Quarter 3 2000 | 30p/min (£18.09/hr) | Leisure |
| | 54p/min (£32.20/hr) | Quarter 3 2000 | 73p/min (£43.79/hr) | Business |
| | 87p/min (£52.30/hr) | Quarter 3 2000 | 119p/min (£71.13/hr) | 1st Class Business |
| Tapley (2008) | 42p/min (£25.20/hr) | Quarter 4 2007 | 47p/min (£28.47/hr) | Business |
| | 108p/min (£64.80/hr) | Quarter 4 2007 | 122p/min (£73.22/hr) | 1st Class Business |

Note: CPI in quarter 3 2000, quarter 4 2007, and quarter 3 2011 were 174, 209.8 and 236.2 respectively (ONS, 2013)

### 4.9 Interpretations, Discussions and Recommendations

At the end of the analyses above, interpretation and discussion of the results were made. The discussion aimed to answer all of the research questions as follows:

- Does perception of time differ with the characteristics of people?
- Does perception of time differ with the personal attitude towards train services?
- Does the main activity of travellers influence the perception of time?
- Does the use of technology influence the perception of time?
- Does the perception of travel time influence the value of travel time?

The discussion was generalised to all related issues in train services, the travel time use and technology advancement. It is anticipated that a more in depth understanding of the role of technology in influencing the perception of travel time will be achieved so that better informed policy decisions with regard to train services provision will take place.

Based on the analysis, interpretation and discussion, recommendations for future research and policies both for government and train operators are proposed.

### 4.10 Case Study

Train travellers were predicted to attain more benefit from the availability of personal technology, which enables them to use travel time more productively compared to other travel modes (Lyons and Urry, 2005). Therefore train travellers have been considered as the subject of the case study in this research.

It was preferable to choose long journeys because travellers have more opportunity to use travel time more productively. Therefore, a national train services with *Wi-Fi* available on board was chosen for this study. However, by choosing a long journey train, the results cannot be compared directly with the results of Wilson (1983) which surveyed passengers on a local service between Newcastle to Hexham with a duration of up to 50 minutes.

This research studied the train operated by the East Coast Main Line Company Limited, travelling between Newcastle and London with an average duration up to 180 minutes. The train service was chosen because it fulfilled the requirement for this study where in term of duration and on-board facilities supported the productive work whilst travelling. The 180 minutes journey duration was long enough for a productive work. Wi-Fi and electric socket were available on-board.

The operation of the East Coast Main Line Company Limited was commenced in 2009 after National Express lost its franchise to National Express East Coast (NXEC). The National Express took over the franchise in 2007 from the GNER (Great North Eastern Railway) after the company suffered from financial losses.

The East Coast is one of the best train services for long journey in the UK as suggested by a recent survey by Passenger Focus, where 91% of respondents were satisfied with its services (Passenger Focus, 2013). Similarly, in terms of punctuality/reliability, sufficient room for passengers and how well the train company dealt with delays, the data provided by Passenger Focus (2013) showed that the performance of the East Coast trains was the best according to the passengers opinion among any other long journey train services in the UK. However, the study also found that in terms of the value for money of the price of ticket, only 62% of respondents were satisfied with the East Coast train service. Compared to other long journey train services, this proportion was the highest ones, suggested that a significant proportion of respondents were neutral or unsatisfied with the ticket price of long journey train services in the UK.

At the time of this study, the East Coast trains provided several on-board services such as Internet access through Wi-Fi service, electric socket, trolley/ coach bar, seat with table, and quiet coach. There were two coach classes available to choose namely the first class and the standard class. The first class has many advantages compare to the standard class such as a more comfortable seat with table, free access to Wi-Fi and free refreshment, however the ticket price was relatively more expensive, depending on the time when the ticket was purchased. There was a probability to obtain a more expensive standard class ticket than the first class if the ticket booked close to the departure time. The free Wi-Fi was also available for the standard class for 15 minutes usage and then at additional cost of £4.95 per hour, or £9.95 for 24 hours.

The main data collection was preceded by a pilot study. More detail of the data collection is described in Chapter 5.

## 4.11 Summary

This chapter has presented the methodological framework and outlined the data collection methods designed to achieve the research aims and objectives. Appropriate methods of data analysis used in this research have been presented and include descriptive statistics and regression to investigate any relationships between the perceived and actual travel time. Cluster and factor analyses are used to investigate the structure of the data. Cluster analysis was mainly applied to explore differences between groups of respondents whilst factor analysis was applied to reduce the data to a small number of factors in the event that some variables are correlated.

The SP data was analysed using MNL modelling. From the model, the value of travel time saving will be estimated. The final step before interpreting the result was to investigate how the relationship between perceived and actual travel time is influenced by individual characteristics and more specifically any communality in responses of the individuals with common characteristics in the clusters and factors. Furthermore, how the common characteristics that influence the value of time (VOT) will be investigated.

# Chapter 5: Data Collection

## 5.1 Introduction

The last chapter provided an overview of the methodological approach which was assumed to be the most appropriate to be employed during an interview in the thesis and outlined the statistical approaches adopted. The interview provides an integrative data between travellers' perception, attitudes, and activities related to the actual journey experience.

This chapter presents in more detail the first step of the methodology, namely processes and tools used to collect the data for this study. The next section explains the questionnaire design followed by questionnaire refinement and execution through on-line survey, self-completion and mail-back. After the discussion of the pilot study, the main survey is described before summarising the chapter. Finally, this chapter will be summarised in the last section.

## 5.2 Designing the Questionnaire

As described earlier in Chapter 4, the proposed method for data collection was a face-to-face interview on the train using a pen and paper completion of the questionnaire form. Carrying out interviews on the trains is very challenging and there is a need to compromise the number of questions to be answered and the limited time made available by the operator and without overburdening the respondent. Therefore, the questionnaire should be designed carefully to ensure the wording of the questions gather the information required in order to be able to deliver the objectives.

The list of information required for this study is shown in Table 5.1. The information required can be categorised into four as follows: 1) Perceived and actual travel time of respondents, 2) Information about the respondents including their socio-economic and journey specific characteristics, travel time use, 3) Perception and attitudes of respondents toward train services, and 4) Trade-off between the time and cost preferences of travellers obtained from SP questions. The questionnaire design will be discussed in detail in the Sections 5.2.1 to 5.2.4.

Table 5.1 List of required information

| No. | Section/ sub section | Information/ data |
|---|---|---|
| *1.* | *Perceived and actual travel time* | |
| | a. Perceived travel time | Estimate of time elapsed whilst travelling on train |
| | b. Actual travel time | Actual travel time calculated from the measure departure time of the train at the station where the respondent boarded the train and the time when the estimate was made by the traveller |
| *2.* | *Personal Characteristics of Respondents* | |
| | a. Socio-demographic | Gender |
| | | Employment status |
| | | Annual Household |
| | | Household size |
| | | Age |
| | b. Specific characteristics of the journey | Origin station where the traveller commenced the journey |
| | | Destination station where the traveller finished the journey |
| | | Journey duration as scheduled |
| | | One-way ticket price |
| | | Station where the respondents boarded the train if different from the original station |
| | | Station where the respondents would alight the train if different from the destination station |
| | | Number of changes involved in the journey |
| | | Type of ticket used (e.q. Advanced-return, open-return) |
| | | Railcard used (ex. Family Railcard) |
| | | Who was responsible for paying the ticket (ex. employer, traveller him/herself, other) |
| | | How was the ticket booked |
| | | When was the ticket booked |
| | | Reason for choosing the ticket |
| | | Number of people in the party if travelling in a group |
| | | Frequency of train use |
| | | Main purpose of the journey |
| | c. Travel time use | Activities of the responder on train during the journey |
| | | Main activity of the responder |
| | | Alternative main activity if no electronic device available |
| | | Electronic equipment brought on journey |
| | | Main electronic equipment used most |
| | | Estimated proportion of time spent using technology based activities during the journey. |
| | | Device used to connect to Internet on train |
| | | Willingness to pay for the provision of Wi-Fi service on-board. |
| *3.* | *Attitudes/Opinions of Respondents Toward Train Services* | |
| | a. Perception and attitude of train services | The importance of attributes relating to the quality of train services |
| | | The satisfaction of attributes relating to the quality of train services |
| | | Attitudes towards train services |
| | | Perception of their feeling when travelling by train. |
| *4.* | *Trading-off between Travel Time and Travel Cost Made by Respondents* | |
| | a. Stated preference | Choice of trade-off between time and cost made by responders based on the scenarios offered to them. |

### *5.2.1 The perceived and actual travel time*

The perceived travel time is the duration of the passage of time believed to have elapsed based on the experience of the travellers. For example, consider a particular journey of x minutes. The travellers may feel that they have been travelling either less or more time than their actual travel time. The difference is due to their actions and experiences during the travel and measures their perceptions.

The perceive time is a psychological aspect of the journey that is difficult to observe or measure and was associated with the estimate of the passage time made by respondents. Therefore it is vital to phrase the questions related to the perceived time very carefully to ensure the right response is received from the interviewee. The question stated included in the questionnaire was phrased as follows.

*"Without looking at your watch, please estimate (in minutes) how long you think you have been travelling on this train?"*

The question allowed the interviewer to initiate the dialogue with the respondent. As people tend to round the travel time into 5 or 10 minutes or its multiplications (Wilson, 1983), the interviewers were made aware of the issue and instructed to not to round up their estimation when responding to this question by giving emphasise to the word, *'in minutes'*.

The time when the respondent began to answer the questionnaire was recorded by the interviewer. This will be used to estimate the actual time (or duration) spent by the respondent in the train. Arrival and departure times of the train with respect to each station were recorded appropriately so that the actual of travel time for all respondents can be calculated with sufficient accuracy. If the respondent boarded the train before the interviewer, the departure times of the train was recorded using an official App for the iPhone named National Rail Application. This App can be used as a real-time train monitor and has a high level of accuracy. The app showed the departure and arrival times exactly the same as those in the real time information system at stations. It was tested and the accuracy was about 1 minute. Actual travel time of a particular respondent was calculated as follows:

*Actual time = Time when the question asked – time when the train departed from the station where the respondent boarded the train.*

### *5.2.2 Information about the respondents*

For the purpose of the data analysis, it is vital to collect socio-demographic and journey-specific characteristics of each respondent. The questionnaire was designed very carefully so that the respondents had multiple options from which to choose an appropriate to specific question. An option "*other*" was provided to cover additional responses not covered by the given options. In this case, respondents were allocated space in the questionnaire so that they were able to explain the reason behind the selection of "*other*". Some questions were designed as open questions so that respondents were given a chance of explaining freely their views.

a. Socio-demographic characteristics of the respondent

   The socio-demographic data provided information that enabled categorisation of travellers into groups based on similar characteristics that may influence their perception of travel time. The socio-demographic questions include gender, age, employment status, annual household income, and the number of members of the respondent's household.

b. Specific characteristics of the journey

   Generally, the purpose of this group of questions was to collect information that may influence their perception of time related to the specific journey made by respondents. The questions included origin and destination stations of the journey, stations where the respondent boarded and alighted the train, in order to make the journey on which they were interviewed and the number of changes included in the journey.

   Some questions were designed to collect information related to the ticket used for the journey such as ticket type, price, booking information and the person who was responsible for paying for the cost of the ticket. The ticket price was used as the base cost in the design of the hypothetical cost for the SP scenarios.

   Other questions included in this questionnaire included the frequency of use of train services within the last four weeks and the main purpose of their current journey. The main purpose of the journey is an important factor considered in most studies in the past with evidence that the influence on perception of time was found for commuter differed from those taking a leisure trip (Ettema and Verschuren, 2007; Glenn Lyons *et al.*, 2007; Jung *et al.*, 2012).

c. Travel time use

Questions concerning activities whilst travelling aimed to collect information about responders travel time use during the journey, not only what activities but also that in which they were engaged most of time (main activity). As the opportunity to multitask increases with the availability of electronic devices, the respondents were asked to confirm whether more than one portable electronic device was used on the train and which one was used most. The estimation of the proportion of travel time used on electronic based activity was asked as well to enable examination of the effect of the duration of using electronic devices to the perception of time. Furthermore, respondents were also asked whether they connected to the Internet and how this was achieved. As the train also offers Wi-Fi service on board, each responder was asked about their willingness to pay for the Wi-Fi service.

### *5.2.3 Perception and attitude towards train services*

There were 15 pairs of importance-satisfaction statements related to each responder's perception of the importance of the aspects of the train services and how satisfied they were with respect to each attributes in turn. Respondents were asked to express their opinions in 7 points of the Likert-scales. These were for importance/satisfaction score 1 referred to very unimportant/very unsatisfied and 7 referred to very important/very satisfied. The attributes included in the statements were as follows:

1. Availability of real-time information (on-line and at stations)
2. Availability of Wi-Fi on trains
3. Availability of Wi-Fi at stations
4. Frequency of train services
5. Able to guarantee a seat
6. Electric power sockets
7. Availability of a quiet coach
8. Reliability of train services
9. Availability of catering services such as buffet car and/or trolley

10. Easily accessible services in the station (e.g. information, ticket purchase)
11. Easily accessible facilities at the station (e.g. platforms, toilets)
12. Easily accessible transport links to and from the station
13. A waiting room at the station
14. Direct train services (i.e. no changes)
15. Ticket price

The easily accessible facilities at the station included the facility for people with disabilities. On analysis, it had been planned to analyse the data from a disabled person separately from an able-bodied individual. However, in this study no responders with disability were involved.

Along with the importance-satisfaction questions, 18 statements of attitude/opinion towards train services were included in this section. The attitudinal questions consisted of 14 statements about the train and journey experiences and 4 statements of Polychronicity Attitudinal Index (PAI) adapted from Kaufman-Scarborough and Lindquist (1999). Kaufman-Scarborough and Lindquist (1999) revealed that 4 statements were accepted measurements of the PAI. The statements are: 1) I do not like to juggle several activities at the same time; 2) People should not try to do many things at once; 3) When I sit down at my desk, I work on one project at a time; and 4) I am comfortable doing several things at the same time

These questions aimed to investigate the degree of polychronic within the participant. As found by Ettema and Verschuren (2007), a person who enjoys doing several activities simultaneously is likely to have a lower value of time. Therefore, this aimed to investigate its relationship with the perceived travel time and their attitude to ICT on trains.

Respondents expressed their agreement to the statements on a 7 point Likert-scales, where point 1 referred to strongly disagree and point 7 referred to strongly agree, in relation to the statements. The statements tested in the questionnaire were as follows:

1. I had the opportunity to work during my journey today.
2. Working on the train is more productive than in the office.
3. The journey seems to pass more quickly when I am using my personal electronic devices, such as a laptop or iPhone.
4. Delays are less frustrating when free Wi-Fi is available on board

5. A small increase in travel time would be acceptable as long as free Wi-Fi is available on-board.
6. A small increase in the cost of the ticket would be acceptable as long as free Wi-Fi is available on-board.
7. The duration of this journey is too long.
8. This train is comfortable.
9. I worry about my personal safety when I travel by train.
10. Travelling by train makes me nervous.
11. Travelling by train is tiring.
12. I sometimes feel unwell when travelling by train.
13. I sometimes feel uncomfortable being around people I don't know on the train.
14. I would encourage people to use this train service.
15. I do not like to juggle several activities at the same time.
16. People should not try to do many things at once.
17. When I am at my office desk, I work on one project at a time.
18. I am comfortable doing several things at the same time.

The initial design of the importance/satisfaction and attitudinal questions used a five point Likert-scale. After conducting the pilot study on-board, it was decided to use a seven point Likert-scale as discussed later in this chapter.

Data coding and analysis method used for the importance/satisfaction and attitudinal data will be discuss in the Chapter 6.

### *5.2.4 Trade-off between attributes of travel costs and travel time using Stated Preference (SP)*

The SP questions aimed to investigate the preferences of a responder when choosing trains services with different characteristics. The attributes considered were travel cost and time. Respondents were presented with a set of hypothetical options which were a trade-off between travel cost and time as three options which were prefer to stay with current choice, to pay more to arrive earlier or to pay less to arrive later.

Deciding the value of attributes proved to be challenging because current ticket pricing policies of train operators offers a wide range of travel costs and ticket options. Some studies used absolute difference values between the attribute of alternatives compared to a specified base alternative (usually respondents recent travel) such as increase £X or decreases £Y (Ramjerdi, 1995; Algers *et al.*, 1996; Sanko *et al.*, 2002; Tapley, 2008). However, there were some disadvantages in this approach as discussed in Chapter 3. After considering several ideas about how to design the attribute level for this study based on the literature, it was decided to use the traveller's one-way rationally accepted ticket price for the specific journey on which the responders were travelling at the time of the interview. This was used as the base value of the journey and the hypothesis values were generated as some variation of levels of fixed percentage of differences from the base value.

In this study, the variations of the level used were: -20%, -15%, -10%, -5%, 0, +5%, +10%, +15%, and +20%. However, in the questionnaire, the attribute value offered to each respondent was the base value and the calculated value as magnitude of the base value plus n% and the base value minus n% for each of n = 5, 10, 15 and 20 for cost and travel time. Attributes and levels used in this study showed in Table 5.2.

Table 5.2 Attributes and its levels

| Level | Base | | Option 1 | | Option 2 | |
|---|---|---|---|---|---|---|
| | **Cost** | **Travel Time** | **Cost** | **Travel Time** | **Cost** | **Travel Time** |
| 0 | Respondent's actual one-way cost. | Respondent's scheduled travel time. | +20% | -20% | -20% | +20% |
| 1 | | | +15% | -15% | -15% | +15% |
| 2 | | | +10% | -10% | -10% | +10% |
| 3 | | | +5% | -5% | -5% | +5% |

As shown in Table 5.2, there are four levels of each attribute that will be combined in the experiment. As the available time to complete the questionnaire was limited, it was decided to minimise the number of scenarios in the design. Using an orthogonal design, the combination of A attributes with L levels of M alternative would be equal to $L^{MA}$. In the case of this study, as there were two alternatives with two attributes, four levels each, the number of combinations would be $4^{2x4}$ equal to 256 profiles. According to Sanko *et al.* (2002) and Rose and Bliemer (2008) the orthogonal design may not be desirable as it may include dominated choices or indifferent alternatives. There are several methods in reducing the number of profiles in the SP such as fractional-factorial methods, block design methods, or using a more advanced design technique such as an efficient design. Those techniques have been examined by Hess *et al.* (2008) and it has been proven that the efficient technique have a better performance than the orthogonal and block design. Therefore, in this study the efficient design was used. The efficient design experiment introduced by Bliemer and Rose (2006), attempted to determine attribute level combinations that minimise the elements in the asymptotic variance-covariance (AVC) matrix (Bliemer and Rose, 2006).

Table 5.3 Final design of experiment

| **Level** | **Base** | | **Option 1** | | **Option 2** | |
|---|---|---|---|---|---|---|
| | **Cost** | **Travel Time** | **Cost** | **Travel Time** | **Cost** | **Travel Time** |
| 1 | Respondents' actual one-way cost. | Respondent's scheduled travel time. | +10% | -15% | -15% | +20% |
| 2 | | | +10% | -10% | -20% | +5% |
| 3 | | | +15% | -5% | -5% | +20% |
| 4 | | | +10% | -5% | -5% | +10% |
| 5 | | | +20% | -10% | -10% | +5% |
| 6 | | | +20% | -15% | -10% | +15% |
| 7 | | | +15% | -15% | -20% | +10% |
| 8 | | | +15% | -10% | -20% | +5% |

Design experiment for this study was produced using software NGene Version 1.0.2 Build: 158 (Ando and Aoshima, 1997). The prior values of the parameters were set to -0.44 for variable travel cost and -0.18 for travel time. These prior values were chosen based on one of the MNL model in Tapley (2008). The final design of experiments is shown in Table 5.3. Option 1 is an alternative which is more expensive but faster by a different fixed percentage of the base option, whilst the option 2 is less expensive but slower by a different fixed percentage of the base option. This level of attributes was designed based on an assumption that in the real world, the faster option is usually more expensive than the slower one.

## 5.3 Questionnaire Refinements and Evaluations

As mention earlier in this chapter, questionnaire evaluations were performed to explore any issues and concerns about the phrasing, wording grammar of the questions and these issues were rectified before finalising the questionnaire to be used in the main survey. During the refinement process, intensive consultations were carried out with several experts within the Transport Operations Research Group as well as visitors from other institutions. Figure 5.1 shows the diagram explaining the process during the questionnaire evaluations.

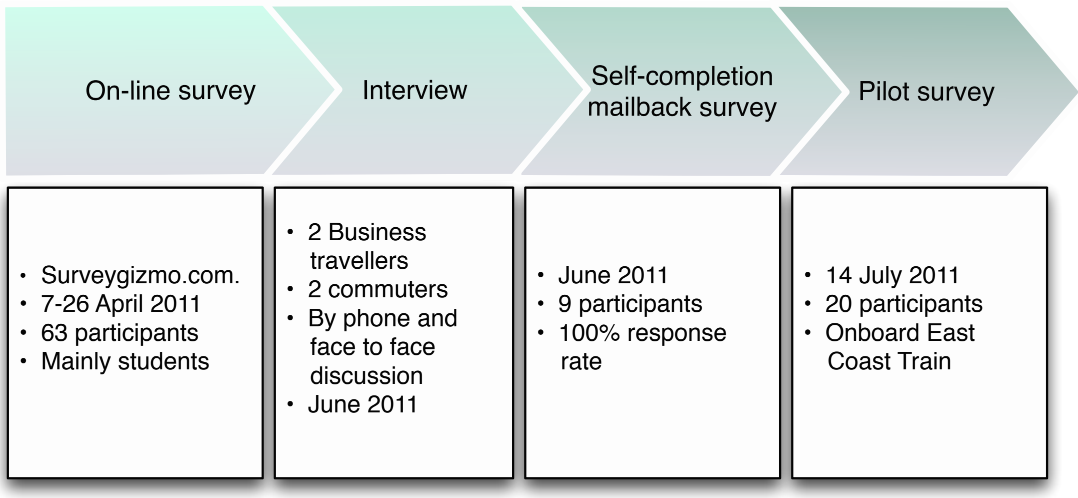



Figure 5.1 Steps in questionnaire evaluations

The questionnaire evaluations were conducted through an on-line survey, four phone interviews, a self-completion mail back questionnaire survey, and a pilot survey on board of the train with real subjects. The latter will be detailed separately and discussed in more detail in Section 5.5. Modifications were made to the questions in response to feedback during each evaluation.

The on-line method was used earlier as it was easily distributed and suitable for questions of attitudes and perceptions of responders toward train services. However, this survey was not suitable for the question: "*Without looking at your watch, please estimate (in minutes) how long you think you have been travelling on this train*?" as the questionnaire can be completed anywhere as long as an Internet connection is available. The findings of the on-line survey were explored more using in-depth interviews in the perspective of business travellers, especially related to the use of electronic devices whilst travelling and the perception of time. After the on-line survey and interview, a self-completion mail-back survey was conducted to obtain more feedback regarding the possibility of implementing the questionnaire in a survey on the train and to obtain an indication of the impact of passenger activities on the perceived travel time. This method was chosen because the letter of approval from the train company and university ethical committee had not been obtained. Finally, a pilot survey was carried out on-board of an East Coast Train after all required documents had been obtained.

### *5.3.1 On-line survey*

The on-line survey was conducted using software called SurveyGizmo. The on-line survey was launched on 7th and ended on 26th of April 2011. The on-line survey was circulated to a limited number of people for initial comments. The objective of this survey was to test whether the wording of the questionnaire was easily understood by responders and feedback was expected to enrich and refine the questionnaire.

Whilst a hundred and fifty (150) people were recorded to open the link, only about a half of them were completed the questionnaire. Instead of completing the questionnaire, some of the responders reported some minor wording problems and with the order of the questions through private message either by e-mail, phone or text message. This was because at the beginning of the survey, the questionnaire was designed without a mandatory item; hence it enabled respondents to review the wording, grammar and structure of the questionnaire without having to complete it. As this survey was the first attempt in the questionnaire refinement in this study, the representation of train passengers in the UK was less important at this stage as well. However, 63 sets of complete data obtained were used to set-up a database for analysis.

The data showed that the majority of respondents were students (62%) in the age group 25-49 (80%). The study found that the main activity of most of respondents was looking at the view, chatting with other passengers and listening to music. In a comparison, a previous study reported in Lyons *et al.* (2007) found that the majority (38%) of travellers spent most of their travel time reading a book for leisure. It was arguable that the difference was due to the characteristics of the specific sample chosen in this study.

Regarding the use of technology whilst travelling, most respondents agree that they have an opportunity to work on the train, but it was not as productive as in the office.

Respondents also agree that the use of electronic devices on the train helped travel time to pass more quickly.

The statements below were the actual words of respondents' responses to request for comment on the question that the use of electronic devices such as a laptop, smart phone and access to the Internet whilst travelling makes travel time appear to pass more quickly.

- *"Agree, because they are occupied by what they are doing with one of those gadgets."*
- *"I really agree because people have something to do in their journey."*
- *"Yes, that is true."*
- *"Not agree, depends on the journey purpose. I just minimise using laptop or smart phone if not urgent in vacation."*
- *"I truly agree. By doing something else during the journey, time is perceived shorter (maybe similar to what Albert Einstein said about time perceived)."*
- *"In my opinion, using laptop, smart phone and Internet whilst travelling makes time seems to pass more quickly. As most of time is used to conduct many activities, the journey time seems to finish faster."*
- *"I agree with the statement since such technologies can make travelling more enjoyable and we may feel the journey time shorter than the reality."*

The results of the survey suggested that the questionnaire was understandable and there was some evidence supporting the hypothesis that the use of technology influences the perception of time. However, as mentioned earlier in this section, given that this initial survey was chosen for the design and test questionnaire the samples were not representative of the actual train users in the UK as most of them were students.

### *5.3.2 Interviews*

As a mechanism to test the comprehension of the questions, the on-line survey made an important contribution to this study. However, because the sample was dominated by students the questionnaire was tested more widely by contacting a cohort of business travellers. Previous studies suggested that business travellers were the persons who gained most benefit from the opportunity to make productive use of travel time (Lyons *et al.*, 2007). Therefore, in this study phone interviews were conducted to gain feedback from business travellers.

Adopted from Lyons *et al.* (2007), the terms of "*productive*" use of travel time in this study did not only refer to activity that had economical worth but also activity that was intentionally conducted to make the journey time more convenient and worthwhile.

Three business travellers, a senior manager and two middle rank staff who were well known by the author were involved in the phone interviews. In addition, an informal interview and discussion session was conducted on the train with rail passengers during a commute from Doncaster to York. The objective of the interviews was to explore the perception of travel time of business rail users in respect to the potential for the productive use of travel time given the recent advancement in technology. Although only a few interviews were conducted, the interviews suggested that the senior manager always used this travel time for work whilst the middle manager used travel time for work if he was giving a presentation at the destination otherwise there was a preference to use the travel time for sleeping. The commuter on the other hand used his travel time to work to prepare for the day ahead and read a book on the return journey. Further details of the results are given in Table 5.4.

The results of the on-line survey and the interview supported the findings of the previous studies that business travellers were more likely to use travel time more productively and the use of electronic devices decreases the perception of time (for example: (Lyons and Urry, 2005; Ettema and Verschuren, 2007)). However, the tendency to use the electronic devices does not mean that they would pay for using the Wi-Fi provided in the train. From the interviews, it was clear that the productive use of travel time depended on several things such as the need to complete a particular task before arriving at the destination, the availability of facilities such as an electric socket; sufficient light; space and duration of the journey.

Table 5.4. Summary of interview results*

| Attribute | Respondent | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Age | 46 | 38 | 40 | 54 |
| Employment status | Employed | Employed | Employed | Employed |
| Position | Senior manager | Middle manager | Middle manager | Staff |
| Sex | Male | Male | Male | Male |
| Journey type | Business | Business | London Area Commuter | Intercity Commuter |
| How do you spend your journey time? | I always do my work whilst travelling to reduce my workload when I come back to my office. | Depending on my workload. I work whilst travelling only if I need to. Otherwise, I prefer to take a nap. | I use my commuter time for reading a newspaper. | I do my work on my journey to office and get relaxation by reading a book on my journey back home. |
| Appreciation from employer? | Yes. In my office, I will write all of my activities during work time on my time sheet including what I did in my business trip. | I can put my activities during the trip on my time sheet. Since the trip itself is a business trip so I did not mention my activities on the journey time. | No | No |
| Preparation? | Yes, I always bring some of my office work when travelling. I bring paper work if the journey involves transfer/changes. I work on laptop if the journey is a long direct trip. | I bring my laptop every day and will use it on train only if necessary. | No. I do not use it. Not enough space and time to work on train. There is no electric socket on the train. I take a free newspaper and read it during the journey. | I tend to minimise my luggage. I bring a laptop only if I think I need it. Ex. to improve my presentation. |
| How long you can work during travelling? | Two hours is the maximum. More than two hours will not be effective. | Depending on what I do. I will spend entire journey time to prepare my presentation. | | My commute time is only 45 minutes. |
| ICTs reduce your perception of time? | Yes, but technology is not the only cause. | It is not about what I do during the trip. But, at what time I depart from my origin and arrive at my destination. Activity whilst travelling is just the way I minimise travel boredom. | | |

*The wording was shortened by the author.

### *5.3.3 Self-completion survey*

Since it was not possible to investigate the perception of time in the on-line survey and the phone interview, a self-completion questionnaire survey which included the question about the perception of time was conducted. The respondents were selected from a group of people who had travelled by train to attend a seminar at Newcastle University. The instructions were provided to the respondent on how to complete the questionnaire. The instructions were as follows:

1. The respondents were asked to open the envelope and to complete the questionnaire at about half way or at any later convenient time during the first leg of their train journey.

2. After completing the questionnaire, respondents were instructed to place the paper in the stamped addressed envelope provided and kindly return by post.

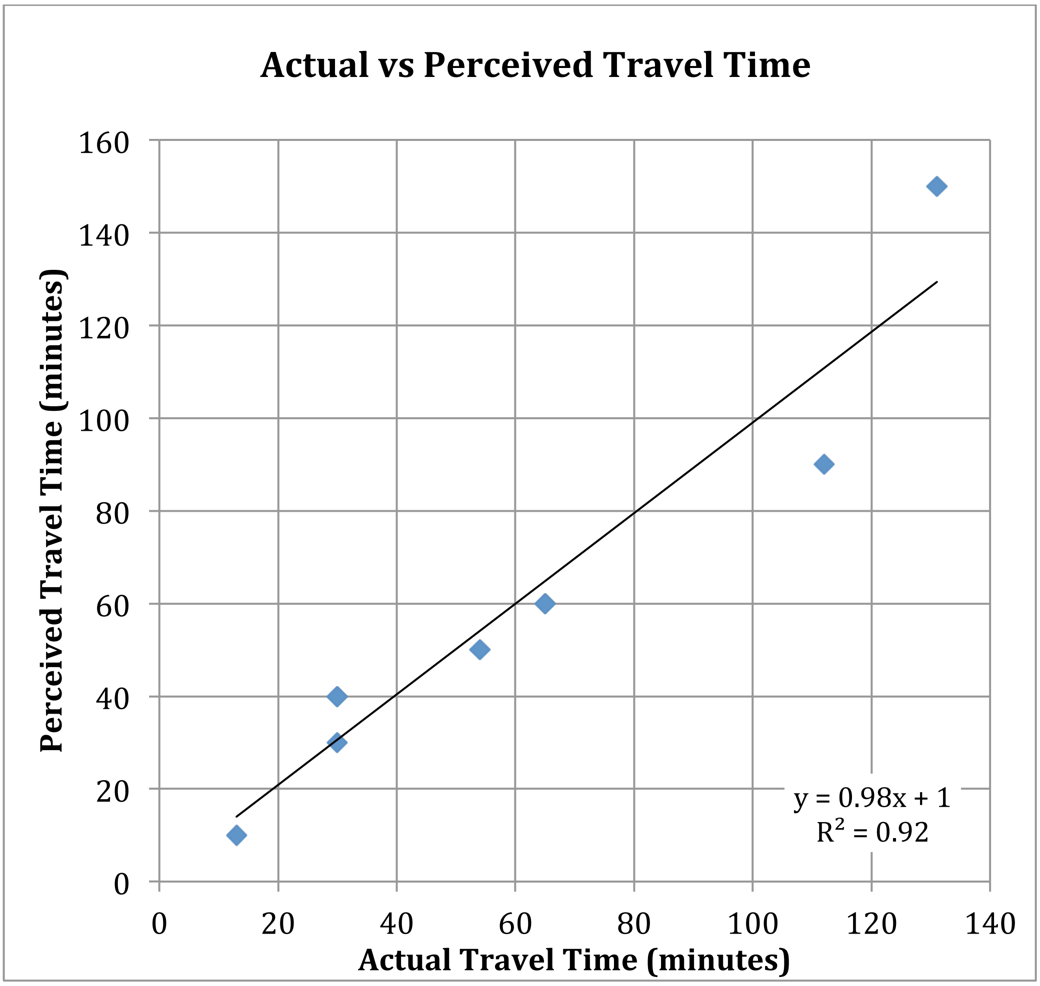



Figure 5.2. The relationship between the perceived and actual travel time of self-completion survey data

There were nine respondents who were approached and handed the questionnaire. All of them completed the questionnaire within a few days of their journey. The destinations of the respondents were London King's Cross Station, Birmingham, Glasgow Central, Leeds and York. This survey was aimed to compare the perception of travel time of respondents to the actual travel time. The perception of time was investigated by asking respondents to estimate their travel time without looking at their wristwatch.

The result shown in Figure 5.2 indicated that the travel time was not statistically significantly different from the actual travel time. In terms of activity during the journey, all participants stated that they engaged in electronic based activity, including working on the computer. It was expected that the perceived travel time would be lower than actual travel time. However the results indicated that the perceived travel time was not statistically significantly different from the actual travel time. The difference between the expected result and the findings motivated further investigation.

## 5.4 Survey Methodology Administration

Based on the scrutiny of the questions and the analysis of the data collected as discussed in the previous section, the questionnaire was amended to improve the comprehension of the questions and enhance the quality of the data. The next step was to develop a procedure to conduct the survey. These were piloted before carrying out the main surveys. The preparation for the study included securing ethical approval from the university ethics committee, completing a risk assessment form, securing informal agreement from the rail company, recruiting surveyors, securing a formal Letter of Acceptance (LoA) from the rail company, training of surveyors, arranging insurance for surveyors and preparing survey equipment (printing questionnaires and name tags). The ethical approval was needed to ensure that the dignity, rights and welfare of the participants were protected. This was secured on 1st July 2011, followed by obtaining informal agreement from East Coast Rail Company to conduct interviews on board their trains.

In the next step, 10 surveyors were recruited with some of them involved in more than one day. Among them were PhD and MSc students from Newcastle University, and the other was an experienced interviewer in the sixth form of a school. The formal agreement and LoAs from the East Coast Rail Company were received on 13 July 2011, enabling surveyors to board and carry out interviews on train. In order to maintain the high quality of the data collection, training for surveyors was conducted in the middle of July before the pilot study was conducted. During the training, surveyors were informed on the details of the survey and how it should be conducted, including an interview trail for each surveyor. East Coast Rail Company provided briefing notes on ethical issues and research-conduct approved specifically for their own staff to carry out surveys on trains. The briefing statements were signed by surveyors before commencing the actual data collection.

## 5.5 Pilot Study

The pilot study conducted on 14 July 2011 was carried out by two surveyors on the East Coast train that departed from Newcastle Central Station at 08:25h towards London, and the East Coast train which departed from King's Cross Station at 16:30h towards Newcastle Central Station. It was the first attempt to use the designed questionnaire in a real environment during this study.

There were specific objectives for this pilot:

a. To evaluate the situation and conditions on the train, including reactions to the approach to take part in the survey and responses from passengers to the questions so that they can be anticipated in the main survey.
b. To evaluate the questionnaire format and the required time for completion.
c. To estimate how many participants can be processed by each surveyor in a day i.e. 1 x return journeys to London.

Two surveyors boarded the train and approached train passengers about 5 minutes after departing Newcastle. There was no particular pattern in choosing the respondents except to approach every available passenger with adherence to research briefing notes from the East Coast Rail Company and consistent with the Newcastle University ethics approval. Passengers were given an opportunity to decline, to participate or to withdraw at any time during the interview.

This pilot study was conducted by using 20 participants. The participants were happy with the questionnaire design and were willing to complete the questionnaire by direct interview. Train crew and passengers were very cooperative and supportive of the survey. There was no indication of any objections during the pilot study, although some valuable views and ideas were received that led to some important modifications in the questionnaire before the main survey, which was conducted the following week.

The pilot study indicated that the order of the questions in the questionnaire form should be changed. The general information of the journey which originally followed the question on perception of time was moved to the first row. This was aimed at gathering the necessary details of the respondents concerning the journey that will enabled the interviewer to calculate the value of attributes for the SP part of the questionnaire, whilst respondents completed the attitudinal questions themselves. A row of statements of consent were added at the beginning of the questionnaire to be read and signed by respondents before commencing the interview.

According to the experience gained during the pilot study, participants were able to complete the interview within 20-30 minutes. Based on this experience each surveyor was expected to conduct up to 10 interviews a day. A modification of the questionnaire was made in order to obtain more responses. The face-to-face interviews were only necessary to complete the perceived travel time question,

*"Without looking at your watch, please estimate (in minutes) how long you think you have been travelling on this train?"*

The participants were able then to complete the questionnaire themselves. This technique saved time thus, enabling surveyors to conduct more interviews.

Dawes (2008) and Dawes (2002) suggested the use of 7 points rather than 5 points of the Likert-scale in the attitudinal questions as 7 points allowed more variance in the responses obtained. However, to satisfy the $\chi^2$ analysis the 7 points needed a larger sample of data compared to a 5 point scale to achieve the statistical confidence based on the data capture rate during the pilot survey and the 7 day duration available for the survey. As a result, it was confirmed that with 22 surveyors a sufficiently large number of participants would be achieved in the main survey. Therefore, the number of points in the Likert-scale was increased from 5 to 7 points and survey sheets modified accordingly.

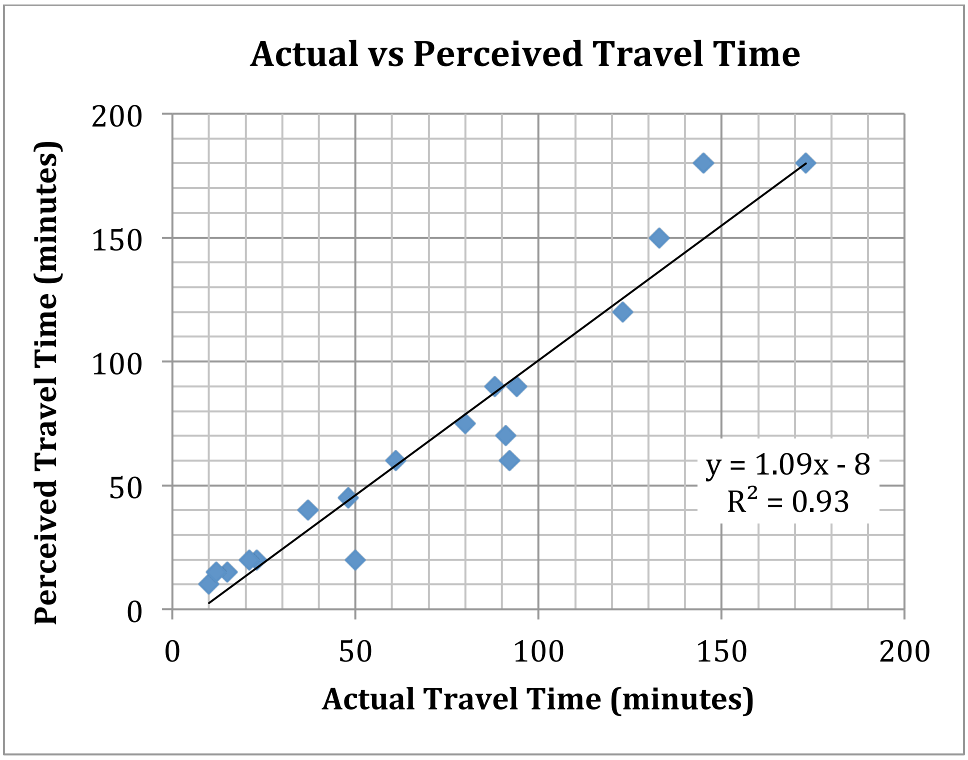



Figure 5.3 The relationship between the perceived and actual travel time of pilot data

The scatterplot of the data collected from the pilot survey indicated that the perceived travel time was lower than actual for journey duration of below 3 hours and higher than the actual for the journey length of more than 3 hours as shown in Figure 5.3. The linear regression analysis indicated that the slope was statically significantly different from one and the intercept from zero. This suggests that the perceived travel time was statistically significantly different from the actual being 8% higher with a negative 8 minutes threshold. The existence of threshold suggested for the particular cohort of travellers interviewed that there was 8 minutes of time in their journey that passed by without notice, bearing in mind that the minimum journey duration was 10 minutes.

### 5.6 Final Questionnaire Design

Based on the results of the questionnaire evaluation and the experiences gained in the pilot survey, the original version of the questionnaire design was revised and improved.

The final questionnaire design has been included in this thesis as Appendix. The following changes were included in the final design:

- Instead of using 5 points, in the main data collections, 7 points were used for the Likert-scale responses to the attitudinal questions.

- A paragraph of introduction of the study was introduced at the beginning of the questionnaire as follows:

  *"Dear Traveller,*

  *Thank you for taking the time to complete this short questionnaire today. This survey is being undertaken by a PhD student at the Transport Operations Research Group at Newcastle University. The information you provide will be treated in strictest confidence and will only be used for research purposes."*

- A statement of consent to be agreed by participants before commencement of the survey was added as shown in Figure 5.4.

**STATEMENTS OF CONSENT**

***(Please tick the box for each statement below)***

| | |
|---|---|
| **1. I agree to take part in the above study.** | ☐ |
| **2. I understand that my participation is voluntary.** | ☐ |
| **3. I understand I am free to withdraw at anytime without giving any reason, without legal rights being affected.** | ☐ |
| **4. I am eighteen years of age or above.** | ☐ |

Figure 5.4 Statements of consent

- The position of the questions related to origin-destination, travel cost and duration of the whole journey as schedule were moved to the first section of the form, following directly on from the consents statements. This action was taken to enable the interviewer to estimate and complete the SP questionnaire form whilst the respondents completed the attitudinal questions. As mentioned earlier in this chapter Section 5.2.4, the SP questionnaire used the percentage of changes of attributes from the base case as the value of attributes. Due to the problems arising from the diversity of fares the SP options were offered to participants based on an estimated value (using the formula: B + (A x B) where

A = percentage of the changes from the base, and B is the base value. For example, if the base cost is £100 and the cost offered in option 1 is +10% (10% more expensive). Therefore the cost was written in the form in this example is £110.

## 5.7 Main Survey

The main survey was conducted from 19$^{th}$ to 25$^{th}$ of July 2011. This was an on-board train survey using the East Coast Mainline service between Newcastle and London. The timetable for this survey was designed to achieve a wide range of passenger journey types including business travellers, commuters, and leisure. It was designed to cover both peak and non-peak periods. The details of the schedule of the survey are shown in Table 5.5.

During the main survey, 299 questionnaires were completed. However, 33 of them were excluded from the analysis. The reasons for this are one or more of the following reasons:

a. Loss of important information such as failure to indicate the time when the estimation of travel time was made. The actual travel time cannot be calculated without the information of the time when the estimation was made. This was an omission on the part of the interviewer.

b. The questionnaire was incomplete as the interview was interrupted or finished early because the respondents declined their involvement because their destination was nearing, they had a pressing task to undertake, declined to continue, etc.

c. The answer was thought to be exaggerated because the estimation of the travel time was more than the full journey time (ex. A day for journey time 3 hours). The answers given indicated that the respondents had misunderstood the question.

Further details relating specifically to the data will be described in Chapter 6.

Table 5.5 Detail of the main survey schedule

| Date | July 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| | **19** | **20** | **21** | **22** | **23** | **24** | **25** |
| | **Tue** | **Wed** | **Thurs** | **Fri** | **Sat** | **Sun** | **Mon** |
| Number of Surveyors | 2 | 2 | 4 | 3 | 4 | 4 | 3 |
| Scheduled Departure from Newcastle | 07.28 | 07.55 | 08.25 | 08.25 | 07.24 | 07.55 | 07.55 |
| Scheduled Departure from London Kings Cross | 16.00 | 16.00 | 16.00 | 16.00 | 16.30 | 16.30 | 16.00 |
| Note for trip from Newcastle | | | | | | | The train was almost empty. |
| Note for trip from London | There was a problem in the King's Cross Rail Station Underground train rode by surveyors did not stop at the station. This led to surveyors being late and taking the next train, which was at 16.30. | | | | | A train had a problem on track that led to an hour delay. However, the survey was finished before the incident. | |

## 5.8 Summary

The process from questionnaire design to data collection has been discussed in this chapter. Comprehensive evaluation and a pilot study were conducted to finalise the questionnaire design and procedure for conducting surveys. Valuable inputs from the questionnaire testing and the pilot study informed appropriate changes to the initial questionnaire design. The main changes to the questionnaire were the order of the questions, adding the respondent's consent statement at the beginning of the questionnaire, and increasing the number of points in the Likert-scale from 5 to 7.

The result of the pilot survey indicated that perceived travel time was influenced by activities on the train including the use of electronic devices. However, whilst the results suggested differences in perceptions depending on respondents, demographic and characteristics may influence their perceptions of time depending on their use of electronic devices on the perception of time. The data collected from the main survey resulted in 266 valid responses and they will be appropriately analysed in detail in the following chapters:

- Chapter 6 has descriptive analysis of the data.
- Chapter 7 discusses the relationship between the perceived and actual travel time.
- Chapter 8 discusses the exploration of the data using cluster analysis and examine the relationship between the perceived and actual travel time of the clusters.
- Chapter 9 discusses the analysis of the attitudinal data of the travellers towards the train services using importance-satisfaction analysis (ISA) and factor analysis (FA), and the relationship between the factors and the perception of time.
- Chapter 10 discusses the analysis of SP data and estimation of the VOT and how the diversion of the VOT by cluster and the activity of travellers whilst travelling.

# Chapter 6: Preliminary Data Analysis

## 6.1 Introduction

This chapter describes the data preparation in a format suitable for analysis using available software and presents the first stage of the analysis of the data. Data cleaning, coding and preparation will be explained first in Section 6.2 followed by the descriptive analysis in Section 6.3 to develop an understanding of the respondents' characteristics, specific characteristics of the journey, and activities of respondents whilst travelling. Section 6.4 presents details of the respondents' journey and Section 6.5 their activities whilst travelling. Next, in Section 6.6 the preliminary analysis of the actual and perceived travel time is presented and followed in Section 6.7 with respondents' responses to the importance and satisfaction questions. Section 6.8 discusses the perceptions and attitudes to train services, and the Stated Preference (SP) questions will be briefly discussed in Section 6.9 before the final summary concludes the chapter.

## 6.2 Data Cleaning, Coding and Preparation

In the process of data cleaning, coding and preparation, the completed questionnaires were first checked and given an identification number.

The second step was to input the data into the commercial software SPSS and NLogit. The next step was checking the completeness of the questionnaires. It was understood that sometimes the respondent felt the need to withdraw from the survey as explained earlier in Section 5.7. The incomplete data was of value and could still be useful for some elements of the analysis. These records were retained in the database and default values were used to manage the incomplete data entities.

The following were considered essential when finalising the dataset:

1. Whether the respondent answered the following question: "*Without looking at your watch, how long do you think you have been travelling on this train*?" If this question was unanswered, the questionnaire was eliminated due to the fact that the perceived travel time had not been recorded.
2. Whether the interviewer had noted the actual time when the time estimation was made. If the interviewer failed to record the time, the questionnaire was not considered because the actual travel time cannot be calculated.
3. Presence of outliers in the data. In some cases it is reasonable to omit data when it is without doubt that the data is in error. For example an over-estimated travel time was omitted from the analysis if it is much higher than 3 standard deviations or unrealistically outside the actual/scheduled leg of the journey time. Also the estimate pointed to the fact that the respondent may not have properly understood the question and instead s/he stated the travel time for the whole journey rather than the leg of the journey relevant to the survey.

After processing the data, 266 records were selected for the analysis. Some data were removed because of one or more of the reasons above. It is noted that several interviews were ended before completion as the respondents decided to withdraw their involvement after answering some of the questions. The discarded records represented about 10% of the total number of interviews carried out.

## 6.3 Respondents Characteristics

The descriptive analysis aimed to present the characteristics of the passengers interviewed and develop an understanding of the distribution of responses. The results were presented in tables and graphs in which statistical properties of the data were included.

### *6.3.1 Distribution of respondents by day and direction*

The main survey was designed to capture different characteristics of the journey such as travel during the peak and off-peak, commuter or non-commuter, weekday or weekend, as well as a short and long duration journey. The on-board train survey was conducted taking into account that the trains departed during 07.24h to 08.25h (Newcastle) and 16.00h to 16.30h (London).

Table 6.1 gives the number of outward/inward journeys covered during the week of the survey. The total number of samples by direction was almost equal. About 66% of the data were collected on the weekdays and the rest were collected on the weekend.

Table 6.1. Distribution of respondents by day and direction

| **Date** | **Direction** | | **Total** |
|---|---|---|---|
| | **Southbound** | **Northbound** | |
| Tuesday 19 July 2011 | 17 | 10 | 27 |
| Wednesday 20 July 2011 | 16 | 13 | 28 |
| Thursday 21 July 2011 | 25 | 32 | 57 |
| Friday 22 July 2011 | 15 | 19 | 34 |
| Saturday 23 July 2011 | 26 | 22 | 46 |
| Sunday 24 July 2011 | 24 | 20 | 44 |
| Monday 25 July 2011 | 9 | 18 | 27 |
| Total | 132 | 134 | 266 |

### *6.3.2 Distribution of respondents by age, gender, employment status and journey purposes*

It is noted that 64% of the respondents were in the range of 25-54 years old. From the gender perspective, 56% were male and 44% female. The figures were compared with the UK population of 49% and 51%, male and female, respectively (Office for National Statistics, 2011). About 78% of them are either employed or self-employed. The data reflected the type of service mainly being for business, which explained the higher proportion of males.

Table 6.2. Characteristics of responders

| Characteristics | Interval | Male | | Female | | Total | |
|---|---|---|---|---|---|---|---|
| | | Count | % | Count | % | Count | % |
| Age | 18-24 | 11 | 4.2 | 17 | 6.5 | 28 | 10.6 |
| | 25-34 | 29 | 11.0 | 26 | 9.9 | 55 | 20.9 |
| | 35-44 | 28 | 10.6 | 25 | 9.5 | 53 | 20.2 |
| | 45-54 | 39 | 14.8 | 23 | 8.7 | 62 | 23.6 |
| | 55-64 | 27 | 10.3 | 14 | 5.3 | 41 | 15.6 |
| | 65 or more | 11 | 4.2 | 9 | 3.4 | 20 | 7.6 |
| | Prefer not to say | 3 | 1.1 | 1 | 0.4 | 4 | 1.5 |
| | Total | 148 | 56.3 | 115 | 43.7 | 263 | 100.0 |
| | | | | | | | |
| Employment status | Employed | 104 | 39.5 | 80 | 30.0 | 183 | 69.6 |
| | Unemployed | 3 | 1.1 | 2 | 0.8 | 5 | 1.9 |
| | Self-employed | 23 | 8.7 | 11 | 4.2 | 34 | 12.9 |
| | Retired | 10 | 3.8 | 9 | 3.4 | 19 | 7.2 |
| | In full time education | 6 | 2.3 | 11 | 4.2 | 17 | 6.5 |
| | Looking after home | 0 | 0.0 | 1 | 0.4 | 1 | 0.4 |
| | Other | 2 | 0.8 | 2 | 0.8 | 4 | 1.5 |
| | Total | 148 | 56.3 | 116 | 43.7 | 264 | 100.0 |
| | | | | | | | |
| Journey Purpose | Employer's business | 72 | 27.5 | 33 | 12.6 | 105 | 40.1 |
| | Commuting to/ from work | 12 | 4.6 | 7 | 2.7 | 19 | 7.3 |
| | Shopping | 0 | 0.0 | 4 | 1.5 | 4 | 1.5 |
| | Personal Business | 17 | 6.1 | 10 | 3.8 | 26 | 9.9 |
| | Visiting friends/ relatives | 21 | 8.0 | 20 | 7.6 | 41 | 15.6 |
| | Holiday/ short break | 8 | 3.1 | 18 | 6.9 | 26 | 9.9 |
| | Leisure | 12 | 4.6 | 8 | 2.7 | 19 | 7.3 |
| | Other | 7 | 2.7 | 15 | 5.7 | 22 | 8.4 |
| | Total | 149 | 56.5 | 115 | 43.5 | 264 | 100.0 |

Tabel 6.3. Comparison of sample of this study and NPS Autumn 2010 and Autumn 2004

| This study | | | NPS Autumn 2010[b] | | | NPS Autumn 2004[c] | |
|---|---|---|---|---|---|---|---|
| Class | Count | % | Class | Count | % | Count | % |
| 18-24 | 28 | 11 | 16-25 | 3065 | 11 | 3936 | 15 |
| 25-34 | 55 | 21 | 26-34 | 4032 | 15 | 4727 | 19 |
| 35-44 | 53 | 20 | 35-44 | 5071 | 18 | 5410 | 21 |
| 45-54 | 62 | 24 | 45-54 | 5992 | 22 | 5136 | 20 |
| 55-64 | 41 | 15 | 55-64 [a] | 5507 | 20 | 3872 | 15 |
| 65 or more | 20 | 8 | 65+ | 3356 | 12 | 2055 | 8 |
| Prefer not to say | 4 | 1 | Not stated | 533 | 2 | 460 | 2 |
| Total | 263 | 100 | Total | 27556 | 100 | 25596 | 100 |

[a]Sum of class 55-59 and 60-64.
[b]Raw data source: NPS Autumn 2010 from Passenger Focus
[c]Raw data source: NPS 2004 from Passenger Focus

Table 6.4 Comparison of samples of this study and NPS Autumn 2010 by employment status

| Employment status | This study | | NPS Autumn 2010[a] | |
|---|---|---|---|---|
| | Count | % | Count | % |
| Employed | 218 | 83 | 20258 | 74 |
| Unemployed | 5 | 2 | 373 | 1 |
| Retired | 19 | 7 | 3916 | 14 |
| In full time education | 17 | 6 | 618 | 2 |
| Other | 5 | 2 | 2391 | 9 |
| Total Valid | 264 | 100 | 27556 | 100 |

[a]Raw data source: NPS Autumn 2010 from Passenger Focus

Table 6.5 Comparison of samples of this study and NPS Autumn 2010 by journey purpose

| Journey Purpose | This study | | NPS Autumn 2010[a] | |
|---|---|---|---|---|
| | Count | % | Count | % |
| Commute | 19 | 7 | 11014 | 40 |
| Business | 132 | 50 | 4236 | 15 |
| Leisure | 113 | 43 | 12306 | 45 |
| Total | 264 | 100 | 27556 | 100 |

[a] Raw data source: NPS Autumn 2010 from Passenger Focus

Table 6.6 Comparison of samples of this study and NPS Autumn 2010 by gender

| Gender | This study | | NPS Autumn 2010[a] | |
|---|---|---|---|---|
| | **Count** | **%** | **Count** | **%** |
| Male | 149 | 56 | 11937 | 43 |
| Female | 115 | 44 | 14775 | 54 |
| Not stated | 0 | 0 | 844 | 3 |
| Total | 264 | 100 | 27556 | 100.0 |

[a] Raw data source: NPS Autumn 2010 from Passenger Focus

With regards to the purpose of the journey, the commuter population accounted for only 7% of the total sample compared with 20% as reported by previous surveys at a national level, for example National Passenger Survey (NPS) 2004 and 2010 (Passenger Focus, 2010). The discrepancy is due to the difference in the data collection methods in the two studies. Data for the NPS 2004 and 2010 were collected by a self-completion questionnaire at the end of the journey, whilst data for this study was collected through passenger interviews during the journey. Due to ethical considerations, only those who agreed to participate in the survey were interviewed. This can be seen as a limitation of this method. As a consequence, the characteristics of the respondents in Table 6.2 may have some differences to other studies in the UK. The other reason for the commuters being less represented in this survey was because they were in a very short journey and therefore unable to complete the questionnaire.

In order to be able to carry out a contingency table test to compare the distribution of data in this study and the NPS Autumn 2010, the categories in both studies were modified as shown in Table 6.3 to Table 6.6. The Pearson Chi-square test on the data in Table 64 to Table 66 showed that the data in this study were statistically significantly different from the NPS Autumn 2010 at the 95% level of confidence. However, in respect of age, it was not possible to carry out the contingency table test due to the fact that the diversity of the categories could not be equalised.

In terms of gender, the distributions were statistically significantly different at the 95% level of confidence where in this study, males were over represented compared to the NPS Autumn 2010 with the proportion of male and female were 54% and 43% respectively. Business journeys were also overrepresented (50%), whilst commuters were under represented (7%) compared with the NPS Autumn 2010 business travellers and commuters were 40% and 15% respectively. These differences reflect the nature of this rail service being the East Coast Mainline operated with the fare structure to attract business passengers over longer distances. The rail service is in competition with the airports, Edinburgh, Glasgow, Newcastle and Durham and thus, passengers will consider the cost of the service against time and convenience in making their choice to use rail.

## 6.4 Respondents Journey Details

This section covers the responses to the questions relating to the specific journey being made at the time of the interview, including the station where they boarded and alighted the train, ticket, rail card used, payment type, reason for choosing the train, and frequency of the train use within the recent four weeks.

### *6.4.1 Station where respondents boarded*

As expected given the targeted group for the East Coast Mainline service, most of the respondents boarded and/or alighted the train at London Kings Cross, Newcastle and York rail stations as illustrated by Table 6.7.

Table 6.7 Station where the respondents boarded and/or alighted the train.

| Station | Boarded | | Alighted | |
|---|---|---|---|---|
| | Count | % | Count | % |
| Edinburgh | 12 | 4.6 | 29 | 10.9 |
| Berwick-upon-Tweed | 2 | 0.8 | 4 | 1.5 |
| Morpeth | 4 | 1.5 | 1 | 0.4 |
| Newcastle | 48 | 17.9 | 25 | 9.4 |
| Durham | 12 | 4.2 | 5 | 1.9 |
| Darlington | 11 | 4.2 | 17 | 6.4 |
| Northallerton | 4 | 1.5 | 5 | 1.9 |
| York | 34 | 12.9 | 48 | 18.0 |
| Doncaster | 3 | 1.1 | 6 | 2.3 |
| Newark North Gate | 7 | 2.7 | 2 | 0.8 |
| Peterborough | 5 | 1.9 | 13 | 4.9 |
| London King's Cross | 123 | 46.4 | 103 | 38.7 |
| Others | 1 | 0.4 | 8 | 3.0 |
| Total | 266 | 100.0 | 266 | 100.0 |

### *6.4.2 Distribution of respondents based on ticket type*

The data presented in Table 6.8 shows the range of ticket type used by the 135 responders. The reason for fewer responses to this question was not clear. It was arguable that they wanted to complete the questionnaire faster before reaching their destination and therefore moved on to the next question. However, there is no convincing evidence to justify the reason for not having completed response to this question. It may have been simply that the ticket had not been booked by the user (people on business tend to have secretaries, personal assistances or mechanisms in place to purchase tickets). On the other hand, some travellers do not understand the ticket system. On the other hand, some travellers do not understand the ticket system.

Based on the ticket type, almost 80%of the respondents were in standard class and the rest were in first class. The majority (65%) were return tickets.

Table 6.8 Ticket type

| Ticket restriction | Class | | | |
|---|---|---|---|---|
| | First | | Standard | |
| | Single | Return | Single | Return |
| Anytime | 0 | 2 | 9 | 20 |
| Advance | 6 | 7 | 18 | 22 |
| Off-peak | 0 | 2 | 4 | 36 |
| Other | 0 | 0 | 9 | 0 |
| Sub-total | 6 | 11 | 40 | 78 |
| Total | 17 | | 118 | |

### *6.4.3 Payment responsibilities*

Regarding the payment responsibilities, about a half of the respondents reported that they were responsible for purchasing the ticket cost from their own budget. Employers were responsible for meeting the cost of about 40% of respondents and 5% were on someone else's budget (respondent's boyfriend for example). Less than 3% of respondents reported that they got a free ticket either as a reward or as family of rail company staff. The detail is shown in Table 6.9. The responders of this question were the same persons who answered the ticket type question discussed in Section 6.4.2.

Table 6.9 Payment responsibilities

| Responsible | Count | % |
|---|---|---|
| Myself | 133 | 52 |
| My employer | 105 | 40 |
| Someone else | 13 | 5 |
| Other | 7 | 3 |
| Total | 258 | 100.0 |

### *6.4.4 Railcard used*

From 255 valid responses, only 87 respondents reported that they had used a Railcard when booking the journey. Refer to Table 6.10 for details. The use of a Railcard reduces the ticket price by approximately 30% (Rail, no date). However, they are designed for frequent travellers (either for holiday, leisure and a university trip) for senior citizens, families, students, and for daily commuters.

Table 6.10 Railcard used

| Railcard | Count | % |
|---|---|---|
| None | 168 | 65.9 |
| 16-25 years old or full time student Railcard | 26 | 10.2 |
| Family and friends Railcard | 12 | 4.7 |
| Senior Railcard | 35 | 13.7 |
| Network Railcard | 1 | 0.4 |
| Disabled Railcard | 1 | 0.4 |
| Other | 12 | 4.7 |
| Total | 255 | 100.0 |

### *6.4.5 Reason to choose the train*

The departure and arrival time were the most reported reasons for the choice of the train. The detail of the reason to choose the train is shown in Table 6.11. It was not surprising that the ticket price was not the most important reason in choosing the train by respondents when their travel arrangements would be governed by business schedules where expenses are paid by the company. However, was this also the case for those who paid the ticket themselves? In order to answer this question, a contingency table analysis was conducted. The result is showed in Table 6.12.

Table 6.11 Reason to choosing a train

| Reason | Count | % |
|---|---|---|
| Price | 41 | 15.8 |
| Departure time | 90 | 34.6 |
| Arrival time | 58 | 22.3 |
| Convenience | 41 | 15.8 |
| Reliability | 3 | 1.1 |
| Number of changes | 1 | 0.4 |
| Other | 26 | 10.0 |
| Total | 260 | 100.0 |

Table 6.12. Contingency table of ticket cost responsibility and important reason for choosing a train

| Important reason for choosing a train | Payment responsibility | | | | Total |
|---|---|---|---|---|---|
| | Myself | My employer | Someone else | Other | |
| Price | 35 | 7 | 0 | 0 | 42 |
| Departure time | 38 | 42 | 5 | 3 | 88 |
| Arrival time | 26 | 27 | 2 | 2 | 57 |
| Convenience | 19 | 19 | 4 | 0 | 42 |
| Reliability | 3 | 0 | 0 | 0 | 3 |
| Number of changes | 0 | 1 | 0 | 0 | 1 |
| Other | 13 | 9 | 1 | 2 | 25 |
| Total | 134 | 105 | 12 | 7 | 258 |

The Pearson Chi-square test showed that the difference is statistically significant at the 95% level of confidence when all of the groups were compared and 99% when only the "*Myself*" and "*My employer*" were included. As expected, the price and departure time were the most important reasons in choosing a train if the person was responsible for paying his/her ticket cost. However, if the ticket cost was paid by their employer or another person, they chose the train based on the departure and arrival times, as well as convenience.

It is interesting to investigate whether the reason in choosing the train was also influenced by the trip purposes; therefore a contingency table analysis was conducted. Table 6.13 showed the result of the analysis where the business trip referred to a trip for employer business, personal business and commuter whilst leisure referred to shopping, visiting friends/family, holiday/short break, and other.

Table 6.13 Reason for choosing a train by trip purpose

| Reason | Trip Purpose | | Total |
|---|---|---|---|
| | Business | Leisure | |
| Price | 14 | 28 | 42 |
| Departure time | 61 | 29 | 90 |
| Arrival time | 37 | 21 | 58 |
| Convenience | 22 | 20 | 42 |
| Reliability | 3 | 0 | 3 |
| Number of changes | 1 | 0 | 1 |
| Other | 12 | 14 | 26 |
| Total | 150 | 112 | 262 |

Table 6.13 clearly showed that the reason for choosing the train was influenced by the journey purpose, where business travellers tend to choose the train based on the departure and arrival time. On the other hand, the leisure travellers' choice was based on the departure time and ticket price. The Pearson Chi-square test confirmed that the distribution was statistically significantly different at the 99% level of confidence.

### *6.4.6 Frequency of train use in the last four weeks*

Most of the respondents who use the rail service studied regularly, between 2-4 times within the last four weeks. About one-third of them used the train only once within the last four weeks. On average, each respondent had travelled by train within the last four weeks, for four times with a standard deviation of 4.8 times. The frequency of using the train is shown in Table 6.14.

Table 6.14 Frequency of train use

| Frequency | Count | Percentage |
|---|---|---|
| 1 | 83 | 31.6 |
| 2-4 | 118 | 44.9 |
| 5-8 | 33 | 12.5 |
| 9-12 | 10 | 3.8 |
| 13-16 | 6 | 2.3 |
| 17-20 | 12 | 4.6 |
| More than 28 | 1 | 0.4 |
| Total | 263 | 100.0 |

## 6.5 Activities whilst Travelling

This section describes the responses relating to the activities conducted and equipment used whilst travelling, and whether and how respondents connected to the Internet.

### *6.5.1 Activities conducted whilst travelling*

Regarding the activities conducted whilst travelling, respondents were asked to choose one or more activities in which they were engaged and also to choose which one of those selected was the main activity.

In this study, the activities were differentiated into 3 groups i.e. electronic based (EB), non-electronic based (NEB) and personal engagement (PE). Electronic based activities are activities that are conducted using one or more electronic devices such as a laptop, mobile phone, and multimedia player. Non-electronic based activities are the activities that require an interaction with other passengers or a non-electronic device such as using a pen and paper, reading a book/magazine/newspaper, chatting with other passengers, and eating or drinking. Personal engagement activities are those that can be conducted without involving other passengers or any devices. Such activities include enjoying the view, sleeping and thinking. Being bored or anxious is included in personal activities. Table 6.15 shows that the NEB activity was the most reported activity followed by EB and PE. Interestingly 29% of responders were engaged in an EB activity, whilst just over half (52%) an NEB activity. Almost a fifth (19%) took part in a PE activity.

Table 6.15 Main activity group of respondents

| Main activity group | Count | % |
|---|---:|---:|
| Electronic Based (EB) | 77 | 29 |
| Non-Electronic Based (NEB) | 139 | 52 |
| Personal Engagement (PE) | 50 | 19 |
| Total | 266 | 100 |

Table 6.16 shows the activities conducted by train travellers during the journey as reported by responders, noting that some passengers do engage in more than one activity. The most frequently reported activities conducted on a train journey include text messaging/ making a phone call, reading printed book/magazine for leisure, eating and/ or drinking, thinking,

enjoying the view, and reading/writing e-mails. The activity reported as the main one during the journey was reading printed book/ magazine/ newspaper for leisure, followed by enjoying the view, reading/ writing e-mail and working on computer. This finding is in line with the previous data in 2004 and 2010 as reported in Lyons *et al.*, 2012, where reading a printed material such as books, magazines and newspapers was the main activity of most travellers.

Table 6.16 Activities conducted curing the journey

| No | Activity | Frequency$^{\alpha}$ | Percentage (%) | Main Activity$^{\beta}$ | Percentage (%) |
|---|---|---|---|---|---|
| ***Electronic based activities (EB)*** | | | | | |
| 1 | Working on computer | 47 | 17.7 | 16 | 6.0 |
| 2 | Reading/Writing e-mails | 115 | 43.2 | 18 | 6.8 |
| 3 | Logging onto the Internet for work related purposes | 48 | 18.0 | 0 | 0.0 |
| 4 | Browsing Internet for leisure | 57 | 21.4 | 2 | 0.8 |
| 5 | Accessing social network website | 45 | 16.9 | 1 | 0.4 |
| 6 | Text messaging/making phone calls | 177 | 66.5 | 16 | 6.0 |
| 7 | Listening to Radio/Music | 50 | 18.8 | 14 | 5.3 |
| 8 | Watching a film/Video | 15 | 5.6 | 4 | 1.5 |
| 9 | Playing digital games | 14 | 5.3 | 1 | 0.3 |
| 10 | Reading e-book | 11 | 4.1 | 5 | 1.9 |
| ***Non-electronic based activities (NEB)*** | | | | | |
| 11 | Pen and paper work | 65 | 24.4 | 5 | 1.9 |
| 12 | Studying | 14 | 5.3 | 2 | 0.8 |
| 13 | Reading printed book/ magazine/newspaper for leisure | 184 | 69.2 | 111 | 41.7 |
| 14 | Playing non-digital games | 8 | 3.0 | 2 | 0.8 |
| 15 | Chatting with other passengers | 58 | 21.8 | 14 | 5.3 |
| 16 | Eating and/or drinking | 170 | 63.9 | 2 | 0.8 |
| 17 | Entertaining children | 9 | 3.4 | 1 | 0.3 |
| ***Personal engagement activities (PE)*** | | | | | |
| 18 | Enjoying the view | 157 | 59.0 | 23 | 8.6 |
| 19 | Thinking | 167 | 62.8 | 16 | 6.0 |
| 20 | Sleeping | 66 | 24.8 | 5 | 1.9 |
| 21 | Being bored or anxious | 19 | 7.1 | 1 | 0.3 |
| 22 | Other$^{\gamma}$ | 7 | 2.6 | 7 | 2.6 |
| | Total Respondent | | | 266 | 100.0 |

$^{\alpha}$ Participant can choose more than one activities.
$^{\beta}$ Participant chooses one activity that spent most of travel time
$^{\gamma}$ Data includes those who answered more than one activity

A comparison between the findings of this study and the data in 2004 and 2010 for relevant main activities is shown in Table 6.17. The possibility of carrying out a contingency table to compare the main activities of those previous studies and this study was explored however because not all of the data in the 2004 and 2010 studies were shown in the report and the raw data was not available at the time this analysis conducted. However, it is worth noting that the data in 2004 and 2010 were based on a self-completion mail-back questionnaire distributed at 700 stations across Great Britain, whilst data of this study was based on an interview on board of the East Coast Mainline service between Newcastle and London. Due to the nature of the studies, it was reasonable to expect dissimilarity of the main activities reported by respondents.

Table 6.17 Comparison between main activity data of 2004, 2010 and this study in % – only relevant activities are shown.

| Main Activities | 2004[α] | | 2010[α] | | This study |
|---|---|---|---|---|---|
| | Out | Return | Out | Return | |
| Reading for leisure[β] | 37 | 39 | 38 | 38 | 42 |
| Window gazing/people watching | 20 | 20 | 20 | 19 | 9 |
| Text messages/phone calls[ɣ] | 2 | 2 | 3 | 3 | 6 |
| Working/studying[ε] | 15 | 14 | 14 | 14 | 9 |
| Listening to music/radio/podcast | 4 | 4 | 8 | 8 | 5 |
| Checking emails | 1 | 1 | 2 | 2 | 7 |
| Eating/drinking | 0 | 1 | 1 | 1 | 1 |
| Talking to other passengers | 7 | 6 | 6 | 5 | 5 |
| Internet browsing | NA | NA | 1 | 1 | 1 |
| Sleeping/snoozing | 3 | 4 | 3 | 4 | 2 |

[α] Source: Lyons *et al.*, 2012.
[β] included reading printed book and e-book.
[ɣ] included messaging/callings for both personal and work related.
[ε] included working on computer, pen and paper and studying.

### *6.5.2 Distribution of respondent based on equipment used*

As expected, most of respondents reported that they carry one or more electronic devices whilst travelling. However, the most frequently used electronic devices were a smart phone and laptop/notebook/tablet PC as shown in Table 6.18. However, as the smartphone capable of being used for more than just a phone conversation or texting, it is arguable to expect that some of them use their smart phone for other activities such as reading/writing emails, browsing the Internet, listening to music, accessing social media or playing games.

Table 6.18 The most frequently used electronic devices.

| Equipment | Count | Percentage |
|---|---|---|
| Laptop/ Notebook/ Tablet | 36 | 17.3 |
| Smartphone | 103 | 49.5 |
| Non-Internet Mobile Phone | 30 | 14.4 |
| Multimedia Player | 19 | 9.1 |
| Audio Player | 3 | 1.4 |
| Video Game | 0 | 0.0 |
| Ebook Reader | 7 | 3.4 |
| Other | 0 | 0.0 |
| None | 10 | 4.8 |
| Total | 208 | 100.0 |

### *6.5.3 How did respondents connect to the Internet*

Table 6.19 shows the distribution of the respondents by the equipment they used to connect to the Internet whilst travelling. From all of the responders who responded to this question, about two-third of the responders reported that they connected to the Internet during the journey. Total responders who completed this question were 215, with 224 responses suggesting that there were several responders who connected to the Internet through more than one device such as 3G on a smart phone and Wi-Fi on a laptop.

Table 6.19 Distribution of respondents by the equipment used to connect to Internet

| Equipment | Count* | % |
|---|---|---|
| Not connected to Internet | 74 | 33 |
| Wi-Fi and laptop/ netbook/ tablet | 27 | 12 |
| Wi-Fi and smartphone | 57 | 25 |
| 3G and tablet PC | 3 | 2 |
| 3G and smartphone | 59 | 26 |
| Broadband dongle and laptop/ tablet PC | 4 | 2 |
| Total | 224 | 100 |

*Respondents can choose more than one option.

In total, the Wi-Fi users were much higher than the 3G users; however, it was not clear whether the Wi-Fi used was the one provided by the rail company on-board the train or other sources such as a tethered signal from a smart phone or broadband dongle. At the time of the interview, the Wi-Fi provided by the rail company was free for the first class passengers. The standard class passengers have an opportunity to gain 15 minutes free usage and at £4.95 per hour or £9.95 for 24 hours for extra usage in standard class. The findings that two-third of responders were connected to the Internet suggested that the access to Internet is demanded by train travellers, however how important the Wi-Fi service provided on board a train is, was still not clear at this stage. In order to answer the question, an importance-satisfaction analysis was conducted and will be discussed in the Section 6.7 of this chapter.

## 6.6 Perceived and Actual Travel Time

This section describes the profile of the actual travel time data recorded by interviewers, the estimation made by respondents and the duration of the leg of the journey scheduled by the train operator. The actual travel time is the recorded duration of the journey from when the train departed from the station where the respondent boarded until the respondent made the estimation of the journey. Data shows that the minimum and maximum actual travel times are 2 minutes and 237 minutes respectively with an average of 57 minutes and a standard deviation of 42 minutes. However, the minimum perceived travel time (estimated by responders) was 2 minutes and the maximum was 180 minutes with average of 58 minutes and a standard deviation of 43 minutes as shown in Table 6.20. Based on the data from train schedule, the minimum and the maximum duration of the leg of the journey from the station where the respondents boarded to the station where respondents planned to alight the train were 15 and 510 minutes respectively with an average of 182 minutes and a standard deviation of 77 minutes. A Normality test showed that each of the above datasets is significantly different from normal distribution. At this stage, the comparison between the data are visualised in the graph 6.1 and 6.2. Further statistical analysis of the data will be discussed in Chapter 7.

Table 6.20. Description of the length of journey, actual and perceived travel time

| | N | Min. | Max. | Mean | SE | SD |
|---|---|---|---|---|---|---|
| Actual Travel Time (minutes) | 266 | 2 | 237 | 58 | 3 | 43 |
| Perceived Travel time (minutes) | 266 | 2 | 180 | 58 | 3 | 43 |
| Scheduled journey time for the leg (minutes) | 265 | 15 | 510 | 182 | 4 | 77 |

A comparison between individual total journey time and the journey duration when the interview took place is shown in Figure 6.1. The figure shows that most interviews were conducted during the first third of the respondents' journey duration.

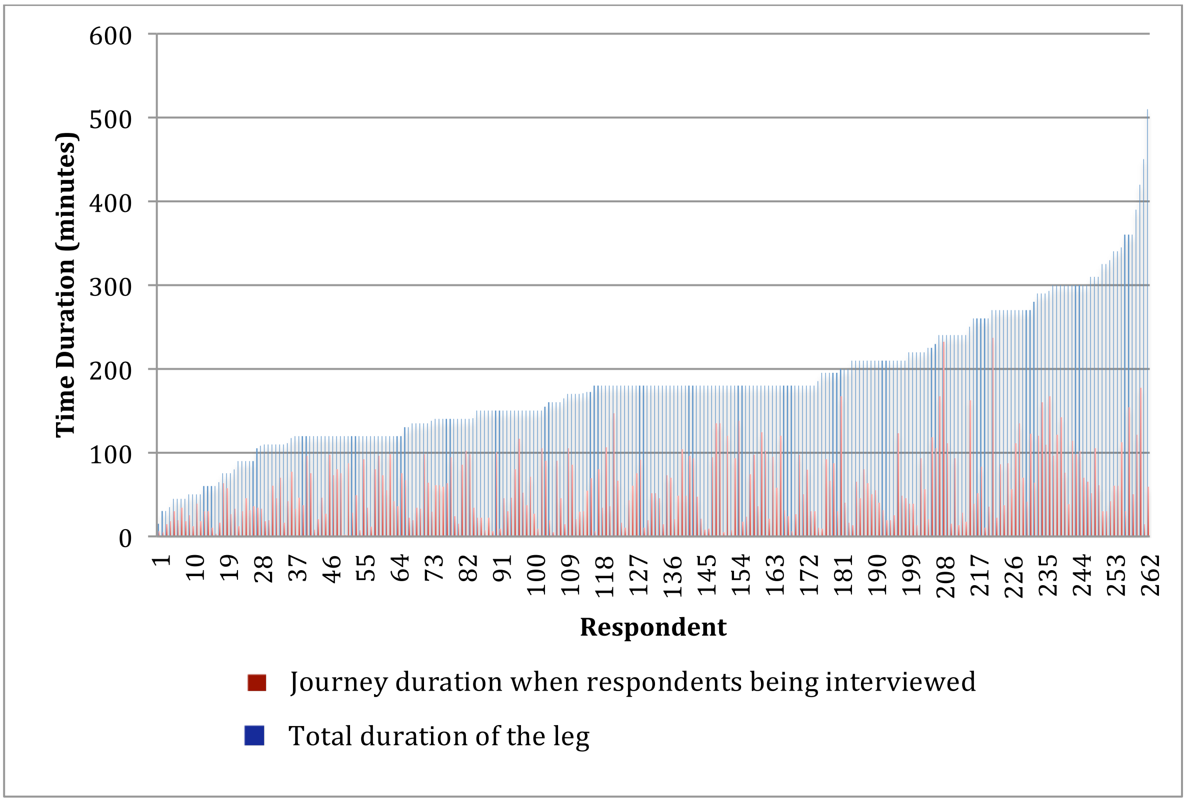



Figure 6.1. Comparison between total journey time and journey duration when the respondents being interviewed

Figure 6.2 shows a comparison between the actual and the estimated duration of the journey made by respondents. The perceived travel time is equal to the actual if the red bar (estimated duration) coincides with the blue line (actual travel time). When the red bar is higher than the blue line, the perceived travel time of that respondent is higher than the actual and vice versa. The perceived travel time is lower than the actual time if the red line is lower than the blue line. The figure shows that most responders perceived travel time as almost equal to the actual time, however, some of them perceived it as being either higher or lower.

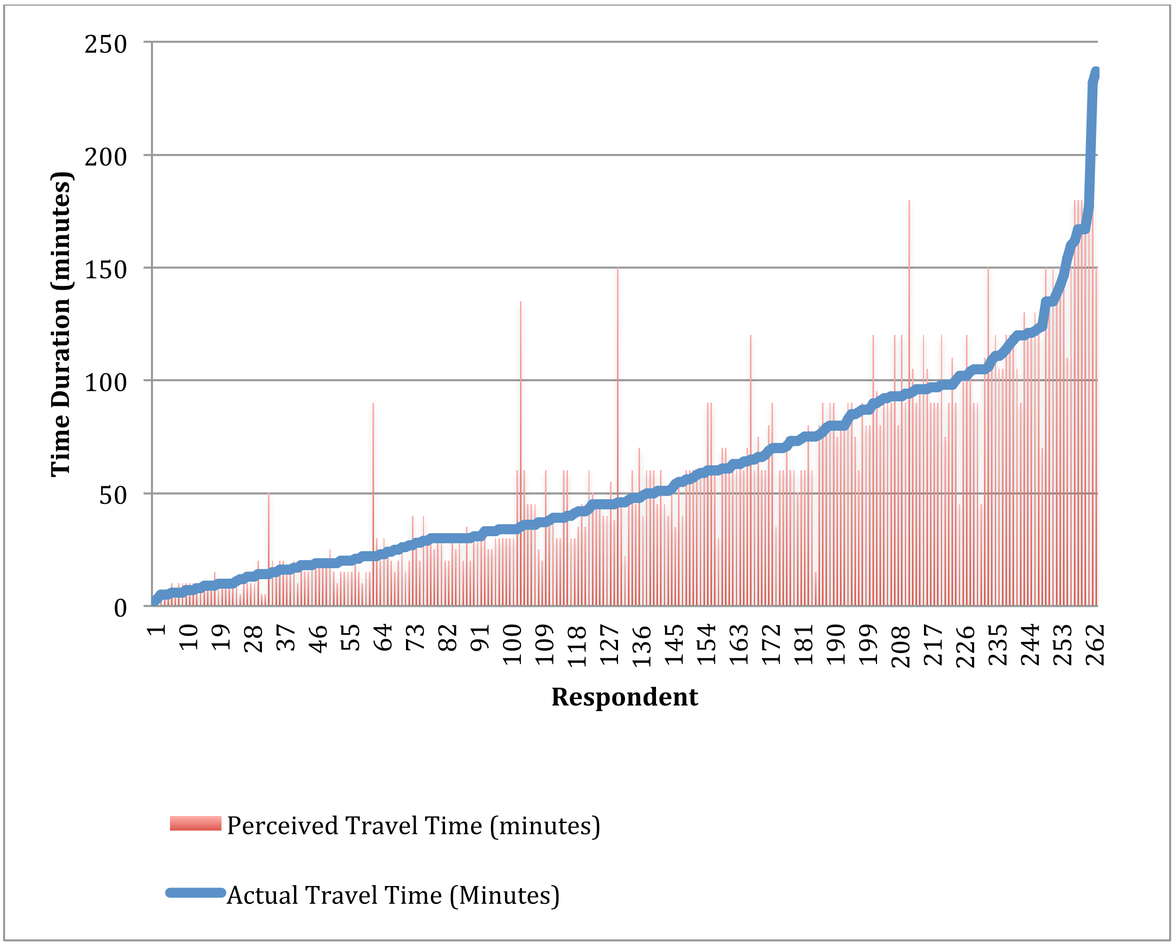



Figure 6.2. Comparison of perceived and actual travel time

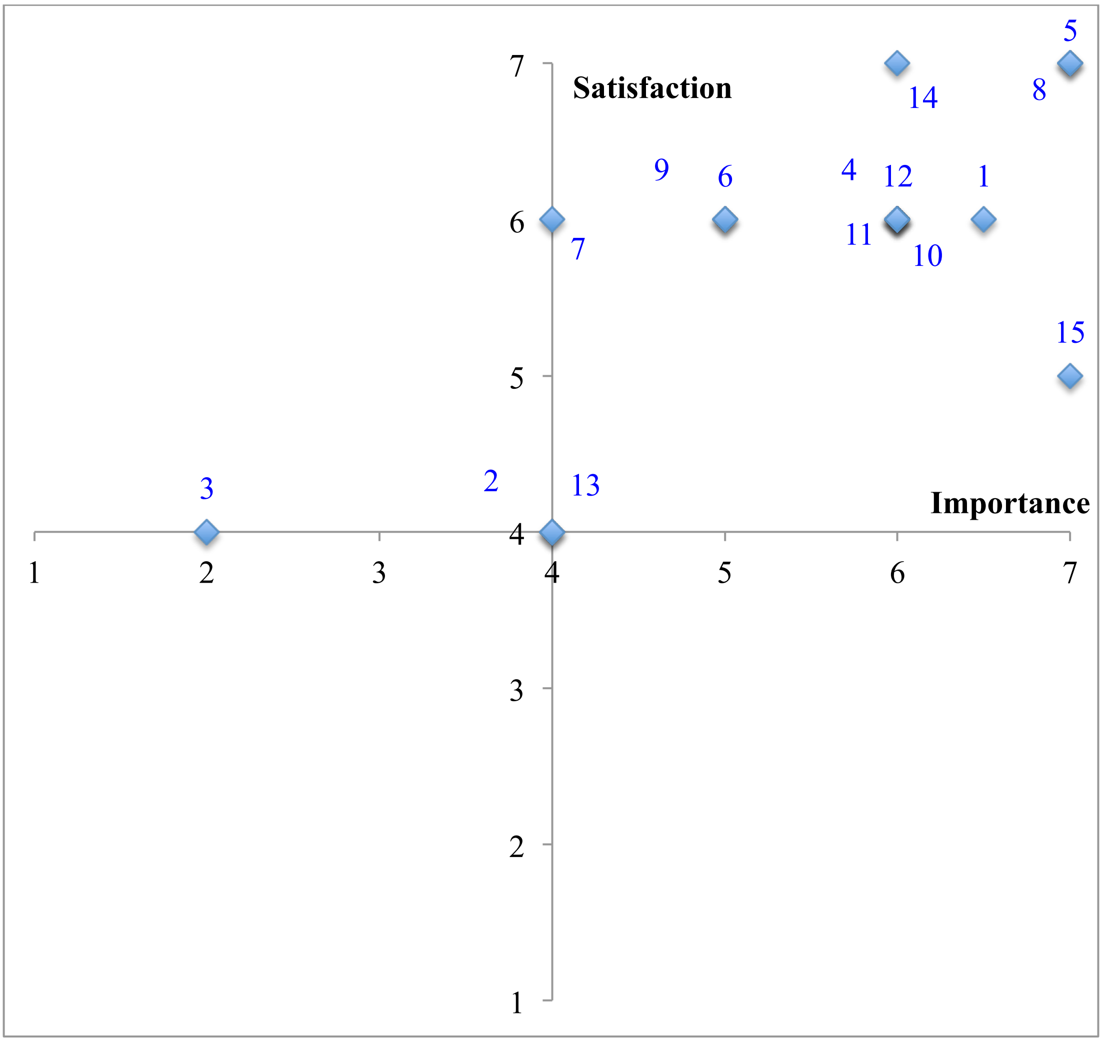
### 6.7 The Importance and Satisfaction Analysis (ISA)

The importance and satisfaction analysis (ISA) in this section aimed to investigate the importance of attributes related to the electric devices compared to other attributes and how satisfied the responders were with the attributes. The mean and median of the importance and satisfaction data are shown in Table 6.21. Kolmogorov-Smirnov and Saphiro-Wilk tests confirmed that the distribution of the responses for each attribute data was statistically significantly different from normal; therefore the median was used in the further analysis as suggested by Thurstone (1931). As discussed in Chapter 2, the Importance and Satisfaction Analysis (ISA) was carried out to compare the importance to the satisfaction of responders and therefore, the mid-point of the Likert-scale was used as the cross hair as was suggested by Oh (2001). Figure 6.3 shows the results of the ISA.

Table 6.21 The mean and median of the Likert-score of *importance* and *satisfaction*

| **Attribute of train services** | **Importance** | | **Satisfaction** | |
|---|---|---|---|---|
| | **Mean** | **Median** | **Mean** | **Median** |
| Availability of real-time information (online and at station) | 5.6 | 7 | 5.6 | 6 |
| Availability of Wi-Fi on train | 3.6 | 4 | 4.2 | 4 |
| Availability Wi-Fi at station | 2.8 | 2 | 3.9 | 4 |
| Frequency of train services | 6.1 | 6 | 5.9 | 6 |
| Able to guarantee a seat | 5.9 | 7 | 5.9 | 7 |
| Electric power socket | 4.5 | 5 | 5.3 | 6 |
| Availability of quiet coach | 3.7 | 4 | 5.0 | 6 |
| Reliability of train services | 6.5 | 7 | 5.9 | 7 |
| Availability of catering services such as buffet car and/ or trolley | 4.5 | 5 | 5.5 | 6 |
| Easily accessible services in the station | 5.3 | 6 | 5.5 | 6 |
| Easily accessible facilities | 5.4 | 6 | 5.4 | 6 |
| Easily accessible transport links to and from station | 5.4 | 6 | 5.4 | 6 |
| A waiting room at station | 3.6 | 4 | 4.6 | 4 |
| Direct train services | 5.8 | 6 | 5.9 | 7 |
| Ticket price | 6.0 | 7 | 4.7 | 5 |

In Figure 6.3 the median of the Likert score of each attribute over all responders were plotted for *satisfaction* (*y* axis) as a function of *importance* (*x* axis). The axes or cross hairs mark the mid-point of the Likert-scale of all the scores over all respondents and over all 15 attributes for *importance* (x) and *satisfaction* (y). The numbers alongside the points label each attribute as defined in the key. In this way, this two dimensional grid illustrates perceived *importance* and how satisfied customers were against the *quality* attributes.




Key:

| | |
|---|---|
| 1 | Availability of real-time information (online and at station) |
| 2 | Availability of Wi-Fi on train |
| 3 | Availability Wi-Fi at station |
| 4 | Frequency of train services |
| 5 | Able to guarantee a seat |
| 6 | Electric power socket |
| 7 | Availability of quiet coach |
| 8 | Reliability of train services |
| 9 | Availability of catering services such as buffet car and/ or trolley |
| 10 | Easily accessible services in the station |
| 11 | Easily accessible facilities |
| 12 | Easily accessible transport links to and from station |
| 13 | A waiting room at station |
| 14 | Direct train services |
| 15 | Ticket price |

Figure 6.3 Importance and satisfaction analysis using median of the Likert score.

Figure 6.3 shows that all scores for the satisfaction were above the mid-point of the Likert scale suggesting that the quality of the attributes were acceptable and satisfied the responders except for attribute number 3 (the availability of Wi-Fi at station). This is reasonable because the Wi-Fi service at the station was not available at the time of interview, however, it was not considered as important for the responders. It is clear that the attributes related to the electronic devices such as Wi-Fi services either on board (attribute number 2) or at stations (attribute number 3) and electric power sockets on board (attribute number (6) were not so important for the responders compared to other attributes such as reliability, ticket price and guarantee of a seat. However, Figure 6.3 shows that the score for most of the attributes were 5 or more suggesting that responders were satisfied with the services. An improvement is required for the attribute of travel cost because the attribute is very important but the satisfaction level is the lowest among the most important attributes.

An exploration to examine the skew in the data confirmed that for those attributes related to the electronic devices, the data were skewed to the left (approaching 1) for the *importance* whilst for the *satisfaction*, the skew was very low for attribute number 2 and 3 and skewed to the right for the attribute number 6. As discussed earlier in this section, it is reasonable that the satisfaction of the Wi-Fi service at the station (attribute number 3) cannot be evaluate by responders, as it was not available at the time. However, for the attribute number 2, that responders were neither satisfied nor dissatisfied might be because they did not use the service, as they already had Internet access through their smart phone. The availability of the electric power socket on board was fairly important for responders and they were satisfied with the service, as the data were skewed to the right.

There was a doubt whether the profiles of the *importance* and the *satisfaction* were influenced by the main activity of responders (EB, NEB and PE as defined in Table 6.16), and therefore a contingency table analysis was carried out. The results are presented in Table 6.22 and 6.23.

Pearson Chi-square test confirmed that the main activity was influenced by the level of importance of the availability of Wi-Fi and electric power sockets on the train and this is statistically significant at the 95% level of confidence. Those who engaged in EB tend to place a higher score on those attributes. However, the availability of Wi-Fi at a station was not statistically significantly different. Pearson Chi-square test also confirmed that different in responses of the satisfaction to the attributes 2, 3 and 6 was not statistically significantly different at the 95% level of confidence.

As the differences in the satisfaction for the three attributes were not statistically significant at the 95% level of confidence, the analysis of this data was not analysed further in the remainder of this thesis.

Table 6.22 Contingency table for the importance of the attribute related to electronic devices and main activity of responders

| **Main activity*** | **Number of response by score** | | | | | | | **Total** |
|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | |
| | **Less importance** | | | | | | **Very importance** | |
| 1. Availability of Wi-Fi on trains | | | | | | | | |
| EB | 12 | 6 | 6 | 10 | 11 | 15 | 13 | 73 |
| NEB | 48 | 12 | 13 | 20 | 19 | 11 | 14 | 137 |
| PE | 15 | 7 | 5 | 6 | 7 | 1 | 4 | 45 |
| Total | 75 | 25 | 24 | 36 | 37 | 27 | 31 | 255 |
| Pearson Chi-square Significance | | | | | | | | **0.04** |
| 2. Availability of Wi-Fi at stations | | | | | | | | |
| EB | 25 | 9 | 12 | 12 | 7 | 1 | 7 | 73 |
| NEB | 63 | 20 | 12 | 16 | 11 | 6 | 7 | 135 |
| PE | 16 | 5 | 10 | 6 | 2 | 2 | 4 | 45 |
| Total | 104 | 34 | 34 | 34 | 20 | 9 | 18 | 253 |
| Pearson Chi-square Significance | | | | | | | | 0.30 |
| 3. Availability of electric power socket on boards | | | | | | | | |
| EB | 7 | 4 | 4 | 9 | 7 | 13 | 29 | 73 |
| NEB | 22 | 11 | 13 | 14 | 29 | 21 | 28 | 138 |
| PE | 10 | 3 | 7 | 7 | 7 | 8 | 3 | 45 |
| Total | 39 | 18 | 24 | 30 | 43 | 42 | 60 | 256 |
| Pearson Chi-square Significance | | | | | | | | **0.00** |

* Detail activities of EB, NEB and PE are shown in Table 6.16

Table 6.23 Contingency table for the satisfaction of the attribute related to electronic devices and main activity of responders

| Main activity* | Number of response by score | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| | Less satisfied | | | | | | Very satisfied | |
| 1. Availability of Wi-Fi on trains | | | | | | | | |
| EB | 7 | 3 | 3 | 20 | 11 | 9 | 16 | 69 |
| NEB | 14 | 6 | 9 | 43 | 13 | 16 | 11 | 112 |
| PE | 5 | 4 | 6 | 7 | 2 | 5 | 4 | 33 |
| Total | 26 | 13 | 18 | 70 | 26 | 30 | 31 | 214 |
| Pearson Chi-square Significance | | | | | | | | 0.11 |
| 2. Availability of Wi-Fi at stations | | | | | | | | |
| EB | 9 | 2 | 3 | 26 | 8 | 9 | 8 | 65 |
| NEB | 14 | 9 | 4 | 52 | 14 | 9 | 5 | 107 |
| PE | 8 | 3 | 3 | 10 | 2 | 3 | 3 | 32 |
| Total | 31 | 14 | 10 | 88 | 24 | 21 | 16 | 204 |
| Pearson Chi-square Significance | | | | | | | | 0.46 |
| 3. Availability of electric power socket on boards | | | | | | | | |
| EB | 8 | 1 | 1 | 7 | 5 | 10 | 40 | 72 |
| NEB | 9 | 2 | 4 | 19 | 17 | 28 | 45 | 124 |
| PE | 3 | 1 | 1 | 6 | 2 | 7 | 16 | 36 |
| Total | 20 | 4 | 6 | 32 | 24 | 45 | 101 | 232 |
| Pearson Chi-square Significance | | | | | | | | 0.07 |

* Detail activities of EB, NEB and PE are shown in Table 6.16

## 6.8 Perceptions and Attitudes Towards Train Services

Eighteen statements related to perception and attitude to rail services were offered to the respondents, who were asked to choose a score from 1 to 7 where 1 meant strongly disagree and 7 meant strongly agree. Table 6.24 shows the responses. More than 80% of responders agreed and less than 20% either disagreed or were neutral to the statement that they have opportunities to work during the journey. However 48% disagreed, 31% were neutral and 21% agreed that working on a train is more productive than in the office.

Any increment of travel time and cost were not acceptable by 49% and 61% of responders respectively even though free Wi-Fi was available on-board whilst the rest were either neutral or disagreed. A more in-depth analysis conducted to investigate the relationship between the attitude to the train services and the perception of time will be discussed in Chapter 9.

Table 6.24 Perceptions and attitudes towards train services

| No | Statement | Response's Count | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 1 | I have opportunity to work during my journey today. | 10 | 5 | 3 | 33 | 36 | 59 | 119 | 266 |
| 2 | Working on the train is more productive than in the office. | 53 | 38 | 36 | 82 | 31 | 14 | 12 | 266 |
| 3 | The journey seems to pass more quickly when I am using my personal electronic devices, such as laptop or iPhone. | 16 | 10 | 10 | 56 | 33 | 66 | 75 | 266 |
| 4 | Delay are less frustrating when free Wi-Fi is available on-board. | 37 | 20 | 17 | 63 | 32 | 35 | 62 | 266 |
| 5 | A small increases in travel time would be acceptable as long as free Wi-Fi is available on-board. | 74 | 30 | 26 | 59 | 19 | 26 | 32 | 266 |
| 6 | A small increases in the cost of the ticket would be acceptable as long as free Wi-Fi is available on-board. | 103 | 35 | 25 | 51 | 20 | 18 | 14 | 266 |
| 7 | The duration of this journey is too long. | 46 | 36 | 34 | 79 | 37 | 10 | 24 | 266 |
| 8 | This train is comfortable. | 5 | 6 | 8 | 52 | 66 | 79 | 49 | 266 |
| 9 | I worry about my personal safety when I travel by train. | 123 | 60 | 28 | 29 | 12 | 6 | 8 | 266 |
| 10 | Travelling by train makes me nervous. | 170 | 53 | 14 | 20 | 3 | 0 | 6 | 266 |
| 11 | Travelling by train is tiring. | 72 | 46 | 36 | 56 | 34 | 15 | 6 | 266 |
| 12 | I sometimes feel unwell when travelling by train. | 160 | 46 | 18 | 20 | 12 | 3 | 7 | 266 |
| 13 | I sometimes feel uncomfortable being around people I do not know on the train. | 131 | 56 | 23 | 28 | 17 | 4 | 7 | 266 |
| 14 | I would encourage people to use this train service. | 8 | 4 | 9 | 43 | 44 | 75 | 83 | 266 |
| 15 | I do not like to juggle several activities at the same time. | 52 | 46 | 33 | 61 | 39 | 17 | 18 | 266 |
| 16 | People should not try to do many things at once. | 52 | 39 | 35 | 69 | 31 | 25 | 15 | 266 |
| 17 | When I am at my office desk, I work on one project at a time. | 58 | 54 | 35 | 47 | 28 | 26 | 18 | 266 |
| 18 | I am comfortable doing several things at the same time. | 3 | 8 | 13 | 39 | 49 | 77 | 77 | 266 |

## 6.9 The SP Data

As discussed in Chapter 5, there were eight scenarios that were offered in the SP questions where respondents were asked to choose one out of three offered alternatives in each scenario. The attributes considered in choosing the alternatives were travel time and cost. In the designed experiment, the scenarios were proposed as a combination of the percentage of changes of travel time and cost from the based case (scheduled travel time and accepted cost by the respondent for the leg of journey when the interview took place). However, in the interview, the percentage of changes in the design experiment was changed to the actual amount of the base case plus (or minus) the changes.

In this section, the amount of the changing values of travel time and cost were plotted in a scatter plot as shown in Figure 6.4. All of combinations of the calculated changes in all scenarios for each of responders were mapped into a two dimensional graph where the horizontal axis referred to the differences of travel time whilst the vertical access referred to the differences in the travel cost. A point in the map referred to a travel time and cost changes for one alternative in a scenario. The number of points (P) depends on number of respondents (N), number of scenarios (S), and number of alternatives (A) where P is equal to NSA.

Therefore in this study (with 8 scenarios, 215 responses and 3 alternatives), the number of points was 5,160. However, some of the points coincided with each other when the changes were equal. The number of points was much higher when the percentage of changes was used compared to the absolute value of changes as adopted in some studies such as Tapley (2008). As a comparison, for the same number of scenarios and alternatives (8 and 3 respectively), the number of points when using the absolute values is equal to 24 regardless of the number of respondents as shown in Figure 6.5. The more points in the scatterplot suggested that the more combinations of levels were used which was expected to result in a better model. The discrete choice analysis for the SP data will be discussed in Chapter 10.

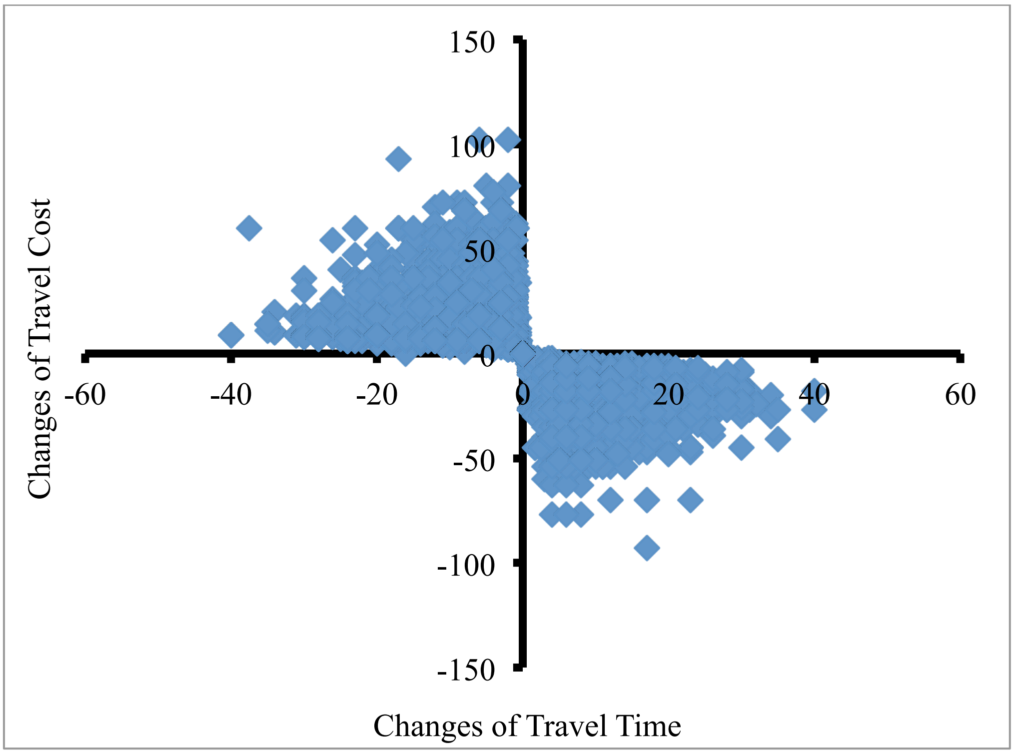



Figure 6.4 Scatter plots of the travel time and cost changes calculated as percentage of the base case

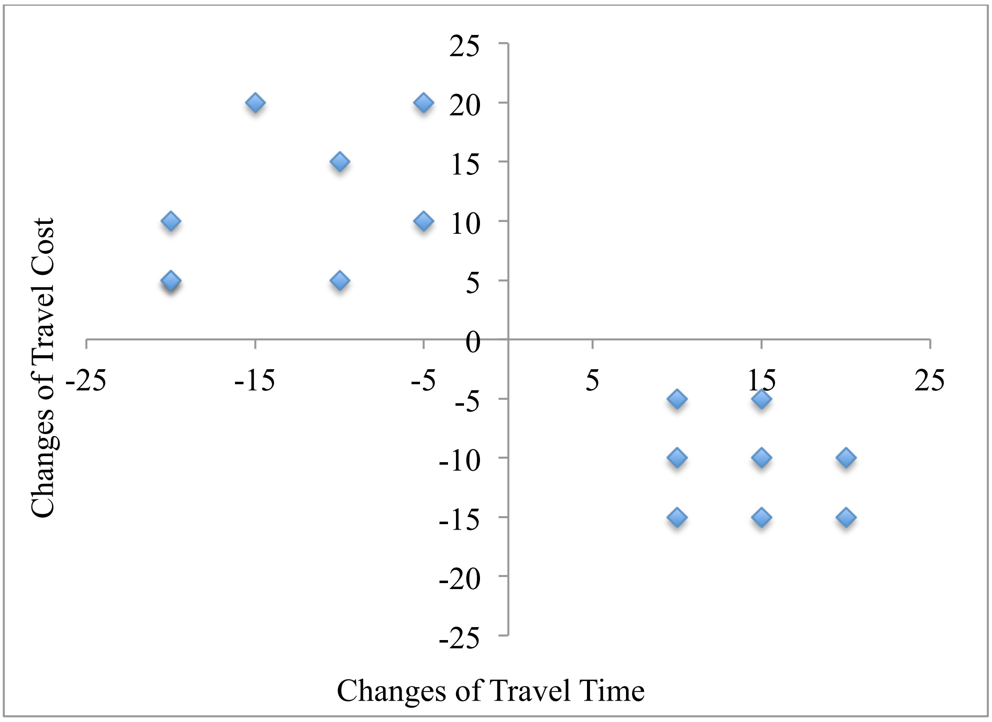



Figure 6.5 Scatter plot of the travel time and cost changes as absolute changes from the base case

### 6.10 Summary

This chapter has provided a preliminary analysis of the survey data to obtain a better understanding of the characteristics of respondents, distribution of responses and preparation of the data for the further analysis. In terms of age distribution of the respondents, the sample represented the distribution of train users found in NPS Autumn 2010 and NPS 2004. However, in terms of gender and journey purposes, male and business travellers were overrepresented, while commuters were underrepresented. This difference is consistent with the service operated for long distance business travel rather than a local commuter service. Therefore the findings of this research provided insight into perceptions of business travel and should be viewed in this context.

The perceived and actual travel time data are not normally distributed; therefore the non-parametric test was used. The importance and satisfaction data showed that ticket price, reliability and frequency of train services were the most important attributes for responders. The ISA showed that responders were satisfied with the service of the train. An improvement is still required especially in relation to the ticket cost, where the satisfaction score was only at a 5 out of 7 scale. The attributes related to the electronic devices such as the availability of electric power sockets, Wi-Fi service on boards or at stations were responded to differently by travellers. Those who mainly engaged in the electronic based activities whilst travelling considered those attributes as important whilst those who engaged in the non-electronic based and personal activities considered them as less importance.

In terms of attitude to train services, significant variations in the responses were observed with both similar and different attitudes towards the various factors. The respondents agreed that ICT opens up the opportunity to work on a train, although in terms of productivity whilst travelling, they showed various views. In the next chapter whether these attitudes are influenced by the particular activities conducted or the specific characteristics of the journey will be explored in more detail.

# Chapter 7: Investigating the Relationship between Perceived and Actual Travel Time

## 7.1 Introduction

A descriptive analysis of the data was presented in the previous chapter which explored the characteristics of responders, distribution of the responses and the preparation for further analysis. This chapter presents the analysis of perceived and actual travel time data in order to investigate the relationship between them. The following sections begin with the background of this analysis and are followed by analysis on the relationship between perceived and the actual travel time. The initial analysis is conducted using the complete set of data. This is followed by the analysis of the segregated data based on journey direction and the main activity conducted during the journey. Conclusions drawn from the analysis will be summarised in the last section.

## 7.2 Background

Previous studies found that the elapsed time was perceived differently, depending on individual age and attractiveness of the activities during the travel (Avant *et al.*, 1975; Dawes, 2001; Danckert and Allman, 2005). However, when it comes to the elapsed time whilst travelling, such studies have provided no indication whether such factors also influenced the perception of travel time.

As discussed in Chapters 2 and 3, Wilson (1980) found that, on average, travel time was perceived by train travellers as being 8% longer than the actual duration. However, this study was conducted on a train service of less than one hour between Newcastle to Hexham and therefore, the results should be considered relevant to local commuting rather than business, as was the case for the Newcastle to London journey studied in this research. Wilson (1980) showed that the perceived travel time was higher than the actual but there was no evidence to suggest why this was the case.

Some research studies predicted that the use of information technology influences the travel time experience and behaviour (Mokhtarian and Bagley, 2000; Mokhtarian *et al.*, 2004; Lyons and Urry, 2005). Technology was believed to decrease the perceived time, as travellers felt the journey time was shorter than the actual (Lyons *et al.*, 2007). This information led to a prediction that the value of travel time would decrease as travel time is more enjoyable (Wardman, 2001; Ettema and Verschuren, 2007; Tapley *et al.*, 2007) and can be used more productively than before (Lyons *et al.*, 2007).

## 7.3 Relationship Between Perceived and Actual Travel Time

The total 266 questionnaires completed during the main survey are used in the analysis. Descriptive analysis of the data was presented in Chapter 6. In this section, regression analysis was conducted to investigate the relationship between the perceived and the actual travel time. The scatterplot for the data fitted with the regression line is shown in the Figure 7.1. The lines in the graphs represent a regression line, the 95% interval of confidence and interval of the prediction value. The key used in the Figure 7.1 will be used in the reminder of this thesis.

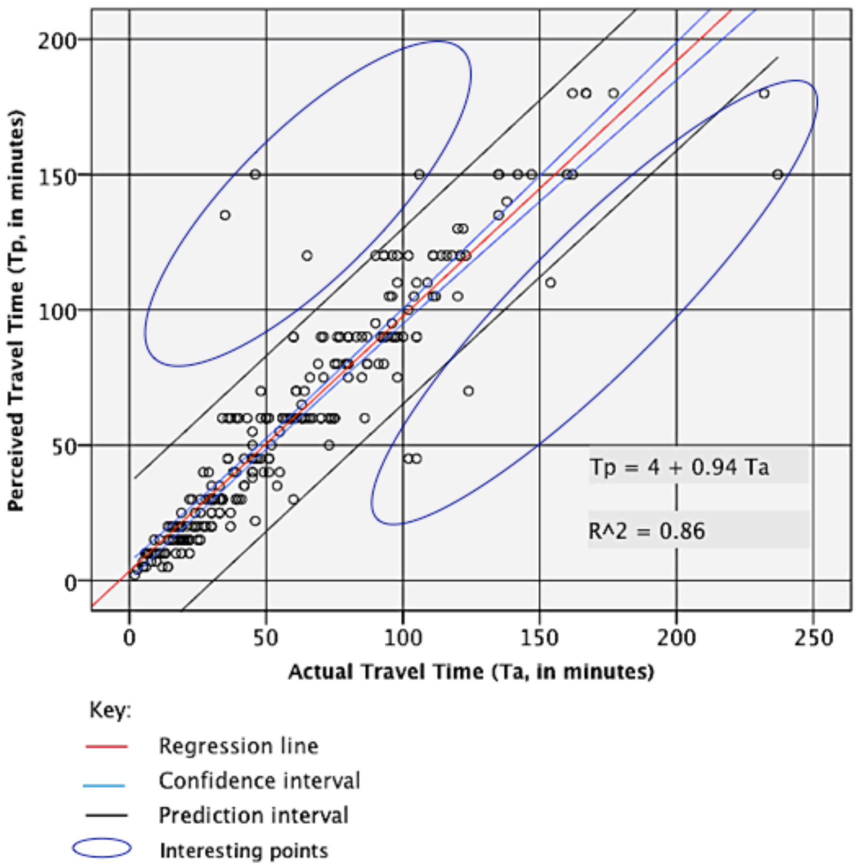



Figure 7.1. Scatter plot of the perceived and actual travel time.

The linear regression was:

$T_p = 4 + 0.94\ T_a$ ($R^2$= 0.86, $S_a$ = 2, $S_b$ = 0.02) ……………………..…………….. (7.1)

Where:

$T_p$ = Perceived Travel Time
$T_a$ = Actual Travel Time
Sa = standard error of intercept
Sb = standard error of coefficient

A diagnostic of the regression analysis was carried out to examine whether the linear regression is a legitimate model for the data. Lane (2013) suggested the diagnostic consisted of:

1. Linearity test.
2. Homoscedasticity.
3. The normality distribution of the errors of prediction.

A linearity test was conducted using visual judgment on the scatterplot and correlation analysis of the data. It is clearly shown in the Figure 7.1 that the data is positively correlated and the distribution of the point in the scatterplot indicates that the relationship between the perceived and actual travel time seems to be linear. This was supported by the Pearson's correlation value of 0.93 and Spearman's Rho correlation of 0.95 which suggested that the data were highly correlated. The coefficient of determination ($R^2$) of the model also supported the assumption that the relationship of the variables might be linear. The possibility to obtain a better statistics using non-linear models was explored and this did not significantly increase the $R^2$ of the model.

A homoscedasticity assessment was conducted by analysing the distribution of residuals around the regression line. Figure 7.2 shows the scatterplot of the regression residual over the predicted value. The data showed that the residual were distributed similarly along the regression line. A slightly larger variant was shown for observations with a higher predicted score, however the number of observations were fewer, and therefore the linear regression was maintained.

The normality distribution of the errors of prediction was assessed using a Q-Q plot for the residual as shown in Figure 7.3. The Q-Q plot shows that the majority of the data was close to the theoretical normal distribution line with a slight deviation at the top and bottom of the line.

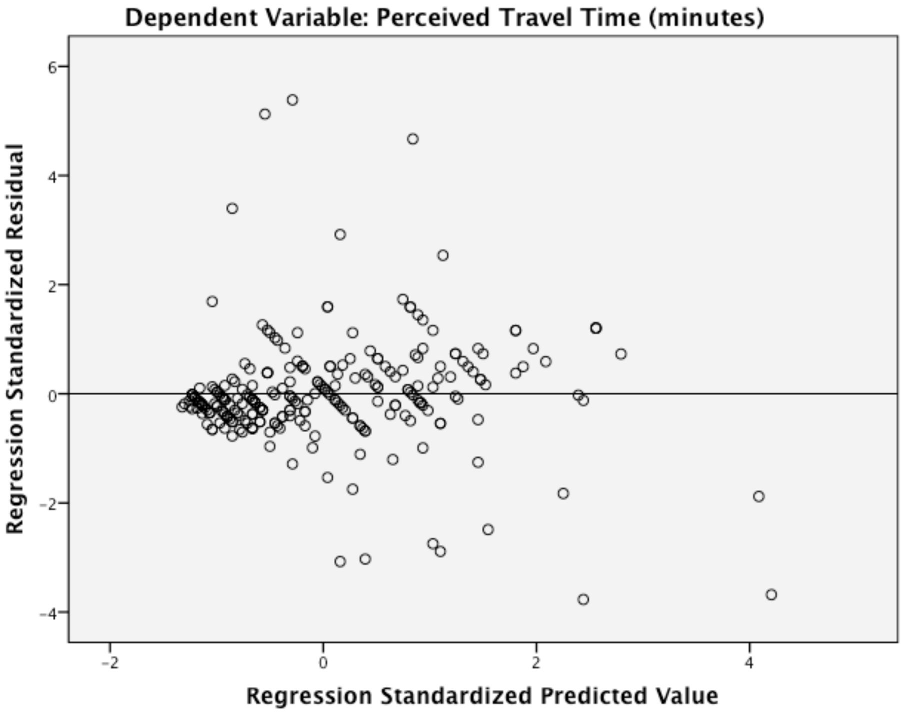



Figure 7.2 Homoscedasticity test of the residual

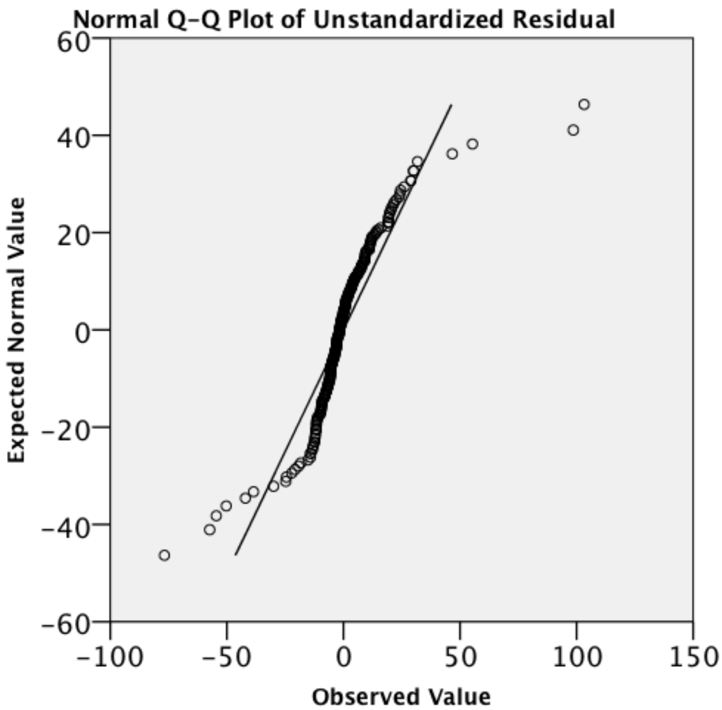



Figure 7.3 Normality test of residual

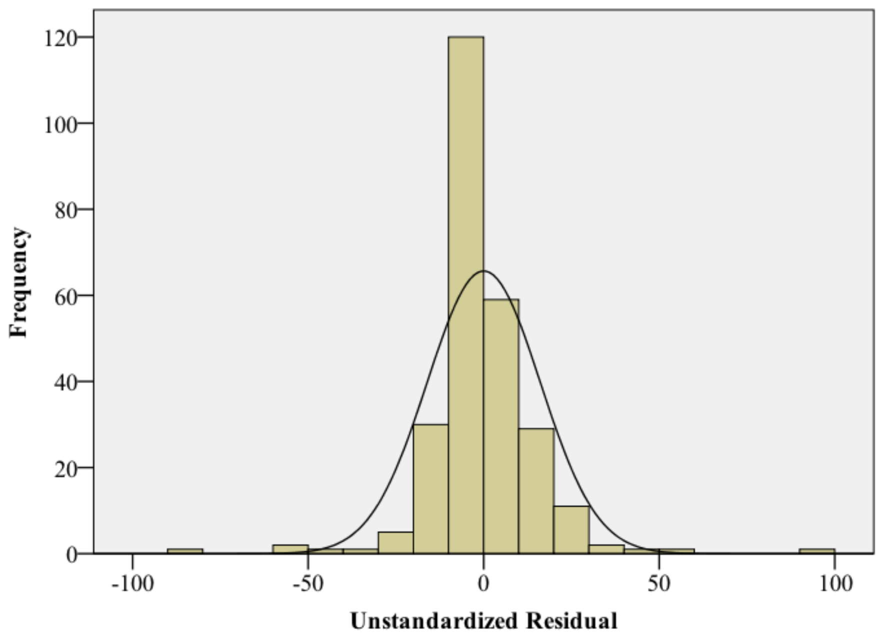



Figure 7.4 Histogram of residual

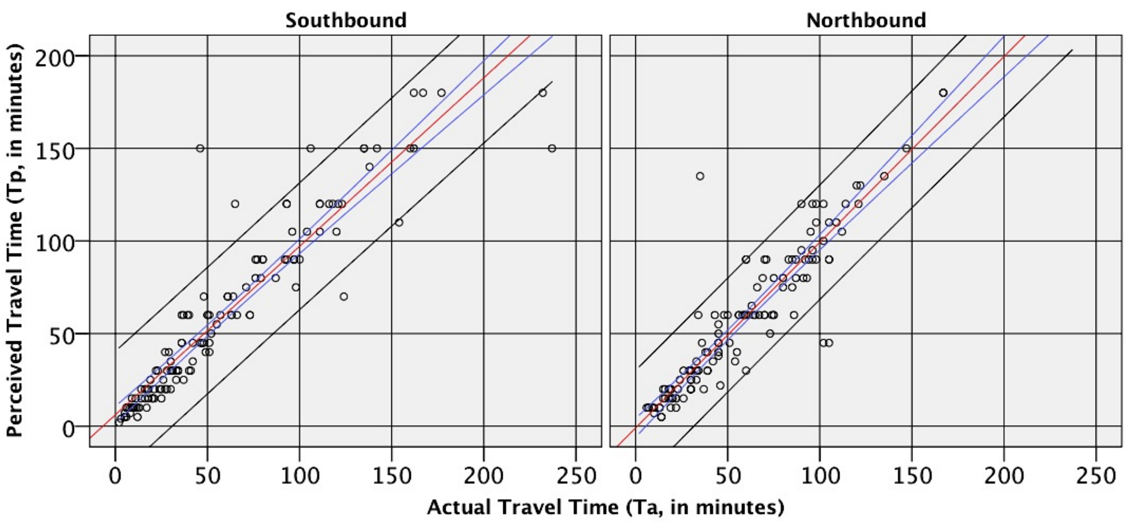
All statistical tests in this study were conducted at the 95% level of confidence unless stated otherwise. The graph shows that the perceived travel time was correlated well with the actual time with an $R^2$ value of 0.85. Statistical test showed that the slope and the intercept of the graph were statistically significantly different from 1 and 0 respectively.

In anticipation of the not normally distributed data, several non-linear models tested along with square root and logarithm transformation of the variable. However, the $R^2$ of the model did not show much improvement from the linear model. Considering the practicality and simplicity, the linear model was selected in this study to analyse the relationship between the perceived and actual travel time.

Back to beginning of this section, Figure 7.1 clearly shows substantial variation in the data and yet the density of data points about the linear relationship reveals some interesting features, as indicated by the oval shapes. The existence of data in the oval shapes may be due to errors. However, potentially the deviation was due to particular features such as time when the journeys were made, main activity, or the socio demographic of respondents leading to a trend that is different from the main data groups. The data also showed the tendency for passengers to round the estimated perception of time to the nearest five minutes interval. This will be discussed further later in this chapter.

## 7.4 Relationship Between Perceived and Actual Travel Time by Direction

This section discusses the relationship between perceived and actual travel time for disaggregated data based on the shift of the journey. As explained in Chapter 5, the southbound data (from Newcastle to London) were collected in the morning and the northbound data (from London to Newcastle) were collected during the afternoon/early evening. Figure 7.5 shows the different perception of time by direction. The perceived travel time for the southbound data was found to be statistically significantly lower than the actual (slope = 0.91) with a $R^2$ value of 0.87. Conversely, the northbound participants perceived travel time to be equal (not statistically significantly different) from the actual with a $R^2$ value of 0.84. As the office hour in the UK begins at 09.00h and ends at 17.00h, it is arguable to expect that in the morning the majority of people are travelling outward (such as going to office) whilst in the afternoon they are returning home. Therefore, the southbound travellers interviewed in this study were possibly on an outward journey, whilst the northbound travellers were on a return journey. However, such interpretation requires further evidence not specifically collected in this survey.




| Direction | Intercept | Slope | $R^2$ | $S_a$ | $S_b$ |
|---|---|---|---|---|---|
| Southbound | 6 | 0.91 | 0.87 | 2 | 0.03 |
| Northbound | -1 | 1.00 | 0.84 | 3 | 0.04 |

Figure 7.5. The relationship between percieved and actual travel time by direction

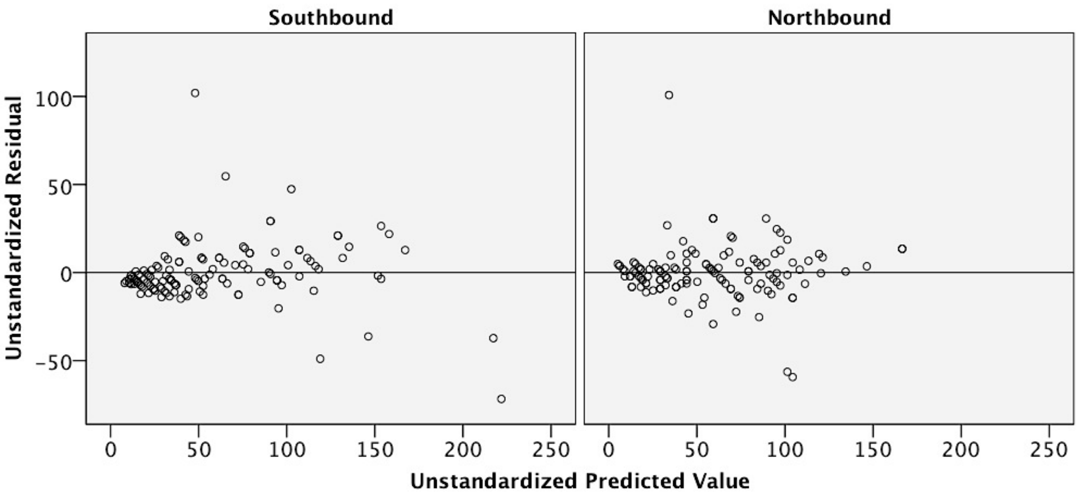


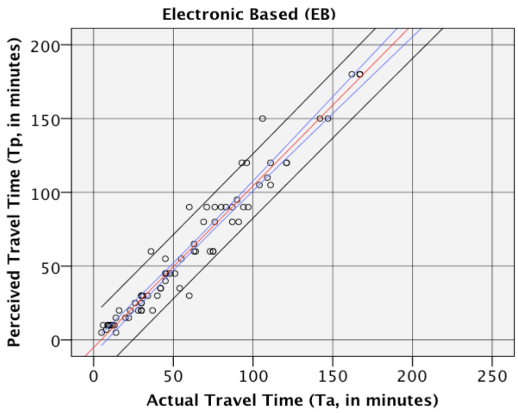

Figure 7.6 Scatter plot of the residuals over the prediction values

The standard error of the intercept and the slope of the model for northbound data was slightly higher than those in the southbound data and therefore indicated that responders who were interviewed in the afternoon tended to make less precise estimations than those in the morning. This may be due to the physical condition of the responders in respect to the nature of the morning journey, where the majority of the passengers were possibly in a fresher condition after having a night's sleep compared to in the afternoon, where the majority of travellers may have been exhausted after being engaged in various activities during the day.

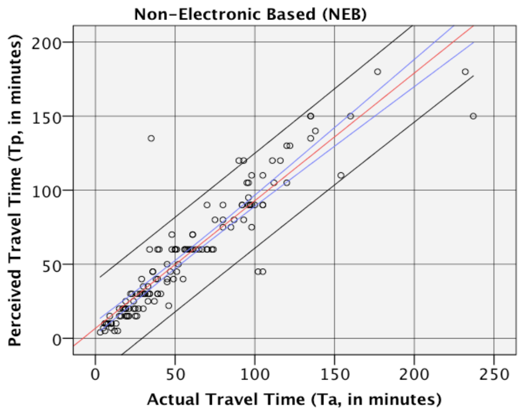
The Figure 7.6 shows the scatterplot of the residual over the prediction value of both data indicated that the variation in perception of travel time increased over the time however the number of observations changes also. There are two possibilities in this case. First, the error was systematic and dependent on the particular characteristic of respondents such as activities or their travel experiences. Second, the error was random. In order to investigate whether the error is caused by the activities conducted by the respondents during the journey and the use of electronic devices, the data was segregated into three main activity groups: Electronic based (EB), Non Electronic Based (NEB) and Personal Engagement (PE) as mentioned in Chapter 6. The effect of the main activity groups to the perceived travel time will be discussed in the following section.

## 7.5 Effect of the Use of Electronic Devices Whilst Travelling

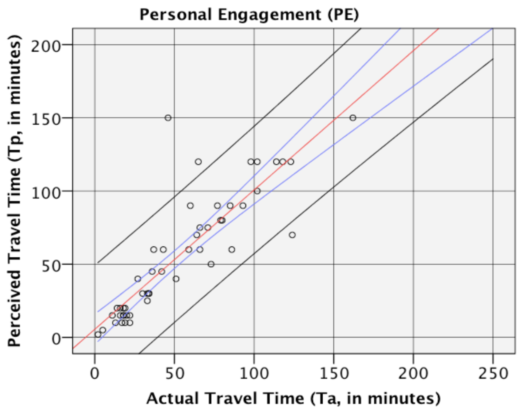
The effect of activities on the perception of time was investigated through disaggregating data according to the main activity. Three linear relationships between actual and perceived travel time for each group were analysed as shown in Figures 7.7 (a), (b) and (c).




a.




b.




c.

| **Statistics** | **EB** | **NEB** | **PE** |
|---|---|---|---|
| Intercept | -5 ** | 7 ** | 6 |
| Slope | 1.10 ** | 0.86 ** | 0.95 |
| $R^2$ | 0.95 | 0.85 | 0.75 |
| Df | 76 | 137 | 49 |
| $S_a$ | 2 | 2 | 5 |
| $S_b$ | 0.03 | 0.03 | 0.08 |
| ** Significant at 95% level of confidence | | | |

d.

Figure 7.7. The relationship between the perceived and actual travel time undertaken by the main activity group. (a) EB, (b) NEB, (c) PE and (d) Linear regression analysis results.

Statistical tests showed that the slopes and intercepts in the case of EB and the NEB were statistically significantly different from 1 and 0 respectively. However, in the case of PE, the slope and the intercept were not statistically significantly different from 1 and 0 respectively. This finding is different from previous study by Lyons *et al.* (2007). Travel time passes more quickly than the actual time when respondents interacted with other passengers or read magazines, newspapers and books. Travellers who were working on the computer or other electronic devices perceived travel time higher than the actual, and those who were enjoying the view whilst travelling, perceived travel time as equal to the actual. However due to disaggregation of data into three groups, it was evident that the statistics of significance was much lower and the density of points about regression was much less. Outliers (outside three standard deviations of the mean) suggested that there was a possible structure in the clustering of the data which required further investigation.

## 7.6 Rounding Effect in Time Estimation

The tendency of passengers to round up or down their time estimation was evident in the data distribution of points as seen in Figure 7.8. The perceived duration of the passage of time remains at 5 minutes time intervals, whilst the duration of actual time varies within a range of about ± 2 minutes.

For this reason, the data were averaged over intervals of 5 minutes for the actual and corresponding perceived travel time. In this way, the rounding error at 5 minutes was addressed without compromising the granularity of the data too much.

The intervals used were ≤5, ≤10, ≤15 and so on up to ≤200 minutes as shown in Figure 7.8(a).

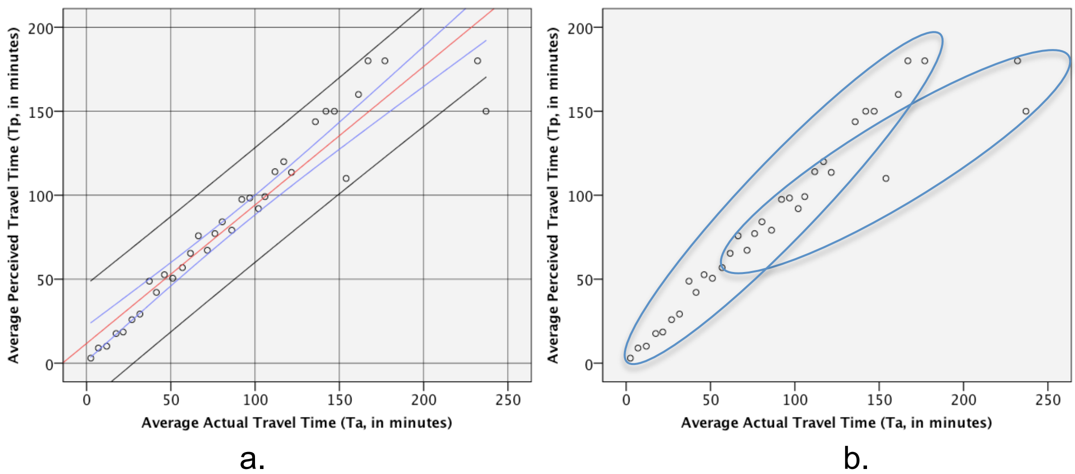


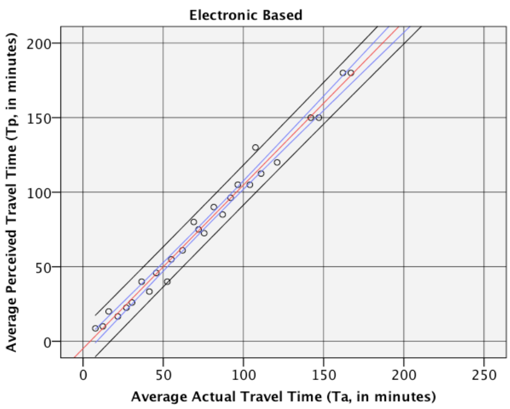

Figure 7.8. Scatterplot of data after being averaged within 5 minutes interval, a) regression line of the averaged data and b) two trends in the data distribution.

The linear regression fitted to the 5 minutes data was:

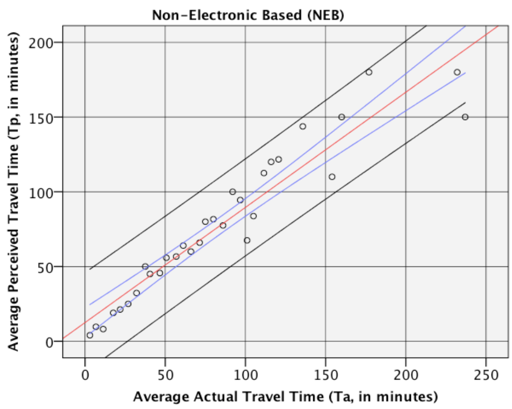
$$T_p = 11 + 0.82\ T_a \qquad (R^2 = 0.90,\ S_a = 5,\ S_b = 0.05,\ df = 33) \ldots\ldots\ldots\ldots\ldots.. (7.2)$$

The intercept was statistically significantly different from 0, and the slope also was statistically significantly different from 1.

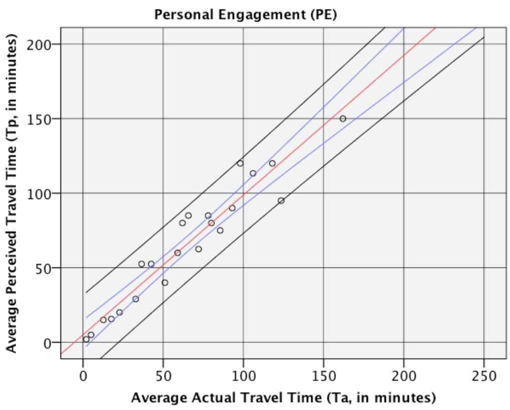
The data also showed that the spread in perception of travel time increases when the journey time increases. Visually, the data showed that there is more than one trend in the data distribution, as shown in Figure 7.8(b). In order to investigate whether the trends were influenced by the main activity of the respondents during the journey, the data was segregated based on the main activity groups such as EB, NEB and PE as shown in Figure 7.9.




a




b




c

| Statistics | EB | NEB | PE |
|---|---|---|---|
| Intercept | **-5*** | **13*** | 5 |
| Slope | **1.10*** | **0.77*** | 0.94 |
| $R^2$ | 0.99 | 0.90 | 0.92 |
| df | 26 | 30 | 22 |
| $S_a$ | 2 | 5 | 5 |
| $S_b$ | 0.03 | 0.05 | 0.06 |

d

Figure 7.9. Relationship between average actual and average perceived travel time undertaken by the main activity groups. (a) EB, (b) NEB, (c) PE and (d) Linear regression analysis result.

The linear regression analysis (see Figure 7.9 inset d) indicates that the slopes are statistically significantly different from 1 for all groups except in the case of PE. Also the intercepts were statistically significantly different from 0, except for PE. A model with intercept constrained to 0 was developed for the PE case. The result showed that the slope of PE model was still not statistically significantly different from 1.

The slope of the EB model was greater than 1 suggesting that the perceived travel time was higher than the actual travel time for those who engaged in the EB activity. In the case of the NEB model, the perceived travel time was 23% lower. However there was a fixed penalty of 13 minutes for all journeys irrespective of the duration. On the other hand, because the slope of the PE model was not statistically significantly different from 1 those passengers enjoying the view or engaged in personal activity perceived travel time as being equal to the actual.

Comparing the models of the averaged data and the original data, the model for EB and PE remain consistent. However, the NEB model was much more different as it had a larger intercept and much smaller slope, whilst the $R^2$ of the models when the data were averaged within 5 minutes interval were higher than those at a 1 minute resolution. The models developed from the original data were preferred to the average because in the more detailed analysis to follow, features of interest may be lost due to the averaging taking place.

### 7.7 Summary

Relationships between the perceived and actual travel time were developed for long distance travel in this study between Newcastle and London. The complete dataset was first used to develop the empirical model using linear regression. The perceived travel time was 6% lower than the actual with a penalty of four minutes irrespective of the journey time lengths. Using the averaged data, the travel time was perceived as being 17% lower than actual with a penalty of eleven minutes irrespective of the elapsed time within the journey. However, when these two regression lines were compared with each other at 95% level of confidence, the difference was not statistically significant. It was suggested that the existence of constant the penalty resulted from the perceived time associated with the effort needed to make the journey, such as the process of boarding the train to settling into a comfortable seat when the activities can usefully begin.

When the data were segregated into the groups for the main activities of EB, NEB, and PE, it was found that instead of decreasing the perceived travel time as anticipated, the use of electronic devices was found to increase it. When the main activity of respondents was non-electronic based activity or personal engagement activity, the perceived travel time was lower than the actual. The lowest travel time was perceived by those who engaged in a NEB activity compared to EB and PE such as reading a printed book and chatting with other passengers. The perceived travel time was higher for those who engaged in an EB activity with such as office work on a laptop, browsing the Internet or making a phone call. It is suggested that because passengers use the travel time productively they judge the passage of time against the amount of work achieved (relative to what they may have achieved had they been in the office) rather than simply the passage of travel time.

This finding is different from previous study by Lyons *et al.* (2007), which found that those who used electronic devices whilst travelling felt travel time passed more quickly. Both of the findings cannot be compared directly because of the methodologies adopted were different. The Lyons *et al.* (2007) study collected off-journey data using qualitative questionnaire reporting retrospectively on a journey already made whilst in this study quantitative data was collected through passenger interviews during the journey. In contrast to the previous studies, for instance Lyons *et al.* (2007), this study substantially improved the representativeness of the data collection process. Travellers are more likely to express their actual travel experience, in particular how they perceived the travel time, during the trip than after the journey has finished. This is one of the novel contributions of this study.

The findings of this study suggested that the use of electronic devices whilst travelling indeed influenced the perception of travel time. Rather than considering travel time as a loss of time, those who use electronic devices whilst travelling obtained a benefit as they used travel time to engage in more productive and more enjoyable activities. Again, the question is if the travel time was not a wasted time then why the perceived travel time was higher than the actual? It may be argued that the travellers estimated the elapsed travel time based on their productivity during the journey relative to productivity at other times. When many demands on your time in the office mean that uninterrupted time whilst travelling is clearly more productive. The use of electronic devices increases potential for more productive activity whilst travelling, therefore, the travel time is perceived to be higher than the actual.

Turning now to the question whether those who engaged in reading a book or chatting whilst travelling, perceived travel time as lower than the actual do not consider the use of time as a productive? Consistent with Danckert and Allman (2005), it suggested that the use of travel time reading a book or chatting with other passengers is interesting, relaxing and enjoyable and therefore the time seems to pass more quickly.

Notwithstanding these generic findings some interesting features were evident in the data and therefore further examination of the data was conducted using cluster analysis techniques which are reported in the next chapter.

# Chapter 8: Exploration of the Structure of the Data by Cluster Analysis

## 8.1 Introduction

The previous chapter presented linear regression analysis to model the relationship between the perceived and actual travel time and revealed some interesting features to be analysed further. This chapter presents the results of the investigation of the data structure using cluster analysis and how the perceptions of time differ among various groups of respondents. First the cluster analysis with due consideration to the socio-demographic and journey specific characteristics of respondents will be discussed followed by the regression analysis used to establish the relationship between the perceived and actual travel time for each cluster identified in the study. Finally, the results will be discussed and a conclusion drawn in the last section.

## 8.2 Cluster Analysis with Respect to Socio-Demographic and Journey Specific Characteristics of Respondents

In order to carry out an in depth analysis of the features emerging from the earlier analyses, a cluster analysis was conducted. Anticipating the difference in perception of time, the perceived and the actual travel time were included as variables in the cluster analysis together with six socio-demographic data as follows:

a. Age
b. Gender
c. Employment status
d. Journey purpose
e. Main activity group
f. Frequency of use of train services

The variables of income and number of persons in a household were also considered to be included in the analysis. Due to the incomplete responses for these variables, they have not been included in the analysis. Since both categorical and continuous data were used, the two-step cluster analysis was identified as the most appropriate clustering procedure for this study (Mooi and Sarstedt, 2011). The clustering procedure offers the flexibility of specifying both the number of clusters as well as the maximum number of clusters. In this analysis, the number of variables used was 8 (which consisted of 6 socio-demographic variables, the perceived and the actual travel time) for the total sample was 266 which was more than the 256 minimum sample size suggested by Formann (1984) as cited by (Mooi and Sarstedt, 2011).

The clustering procedures followed in this analysis have been discussed in Chapter 3. Before the clustering process started, the variables were examined for any substantial collinearity. When two or more data variables were highly correlated, these will be over-represented in the system (Mooi and Sarstedt, 2011). Therefore, Spearman's correlation analysis was conducted to determine inter dependency between the variables. The perceived and actual travel time variables were not included in the correlation analysis because high correlation was expected from these two variables. The result showed that none of the variables were highly correlated (more than 0.90) as illustrated in Table 8.1.

Table 8.1. Spearman's correlation coefficient of 6 socio-demographic variables*

| | **Age** | **Gender** | **Employment status** | **Journey purpose** | **Main activity group** | **Frequency of use of train services** |
|---|---|---|---|---|---|---|
| Age | 1.000 | | | | | |
| Gender | -0.135 | 1.000 | | | | |
| Employment status | 0.161 | 0.037 | 1.000 | | | |
| Journey purpose | -0.69 | 0.225 | 0.382 | 1.000 | | |
| Main activity group | 0.161 | 0.023 | 0.128 | 0.154 | 1.000 | |
| Frequency of use of train services | -0.024 | 0.249 | -0.129 | -0.332 | -0.096 | 1.000 |

*Note: the perceived and the actual travel time variables were excluded. The critical value is 0.90 as suggested by Mooi and Sarstedt (2011).

The distance between two objects was computed using log-likelihood cluster analysis. Both Akaike's Information Criterion (AIC) and Bayes Information Criterion (BIC) were tested to select the optimal number of clusters. The result showed that compared to BIC, the AIC produced a higher number clusters and a lower quality of fit. Therefore, the BIC result was used further in this analysis.

Four clusters were extracted from the output of the program. The clusters extraction was mainly based on the age of the respondent, followed by employment status, gender, main activity group, journey purpose, frequency of using train services, and perceived and actual travel time respectively. All clusters were dominated by *employed on business trip* except for cluster 3. *Mature employed male on business trip* dominated cluster 1, whilst cluster 2 was predominantly *younger employed on business trip*. Cluster 3 consists mainly of *elderly males self-employed/ making a leisure trip* and cluster 4 represents *matured employed female on business*. In terms of the main activity groups, NEB was dominated all clusters except cluster 2, which was dominated by EB. Respondents in cluster 1 seemed to be frequent train users compared to those in other clusters. The cluster profiles are detailed in Table 8.2.

Table 8.2. Detailed descriptions of the respondent groups emerging from the cluster analysis ordered by the importance of predictor

| Attribute | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| **Number of Respondents** | 74 (28.4%) | 84 (32.2%) | 44 (16.9)% | 59 (22.6%) |
| **Age** | 45-54 (45.9%) | 35-44 (35.7%) | 65 or more (43.2%) | 45-54 (37.3%) |
| **Employment Status** | Employed (91.9%) | Employed (72.6%) | Self-Employed (47.7%) | Employed (89.8%) |
| **Gender** | Male (100%) | Male (52.4%) | Male (65.9%) | Female (100%) |
| **Main Activity Group** | NEB (74.3%) | EB (63.1%) | NEB (40.9%) | NEB (81.4%) |
| **Journey Purpose** | Employer Business (62.2%) | Employer Business (38.1%) | Visiting friends/ family/ relatives (29.6%) | Employer business (33.9%) |
| **Frequency of using Train Services** | 5.58 | 4.19 | 3.82 | 2.53 |
| **Perceived Travel Time** | 49.08 | 61.89 | 63.45 | 54.81 |
| **Actual Travel Time** | 51.65 | 60.39 | 60.52 | 55.93 |
| | | | | |
| **Cluster Description** | Frequently travelled mature males on business. | Frequently travelled younger employed on business. | Infrequently travelled elderly males for leisure. | Infrequently travelled mature females on business. |

In order to explore the distribution of the main activity in which respondents were engaged during their trip, a crosstabs analysis was conducted for each clusters. The results showed that reading printed materials such as a book, magazine and newspaper for leisure was reported as the the main activity conducted by the respondents across all clusters. However, the proportion of those who engaged in reading printed materials were not the same among clusters. In cluster 1 the highest proportion of respondents with an interest in reading printed materials was 66.2% compared to 17%, 32% and 54% for cluster 2, 3, and 4 respectively. Therefore, it is reasonable to presume that cluster 1 was characteristically the group of those who engaged in reading printed materials. Similarly, cluster 4 was dominated by those who engaged in reading printed materials (54%). There was no single activity that dominated cluster 2.

The percentage of those who were engaged in reading printed materials, working on computer, reading/writing e-mails, text messaging and making phone calls, or listening to music, was almost equal. Interestingly, in the clustering process when all activities were considered the cluster 2 was dominated by those who engaging in EB activities. Relative to 1 and 2, cluster 3 also were engaged mostly by NEB (41%). This proportion was similar to the sum of those who enjoyed the view and their own personal thoughts (36%). Therefore, cluster 3 was the only group engaged equally in NEB and PE activities. Figures 8.1 to 8.4 show the main activity in detail conducted by the respondents of each cluster whilst travelling.

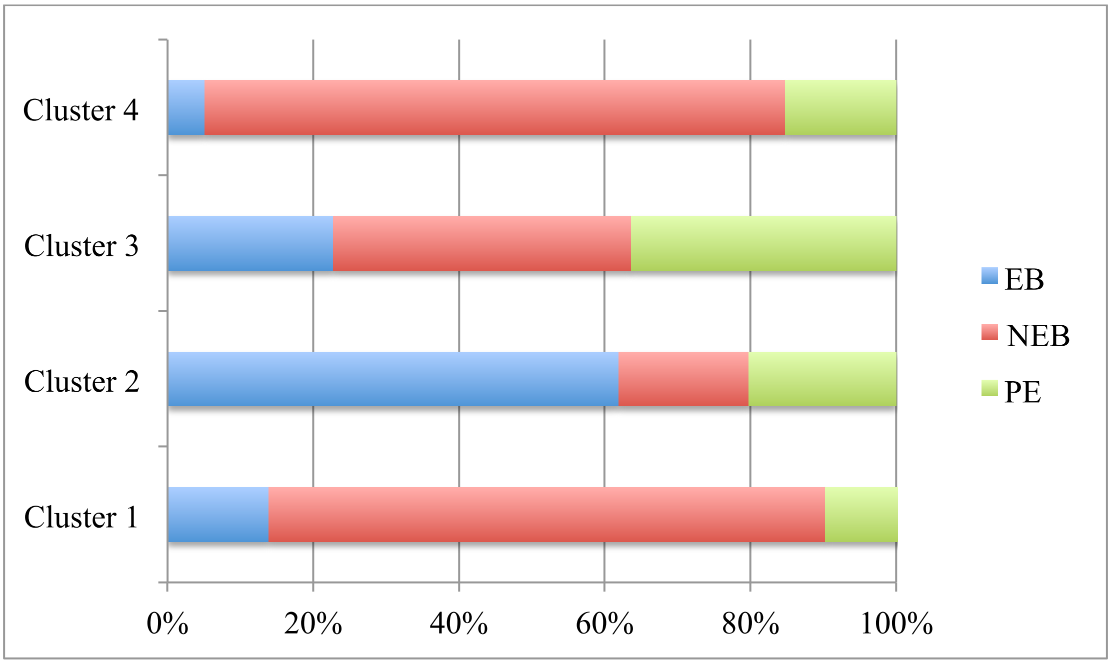



Figure 8.1 Comparison of proportion of main activity group by cluster

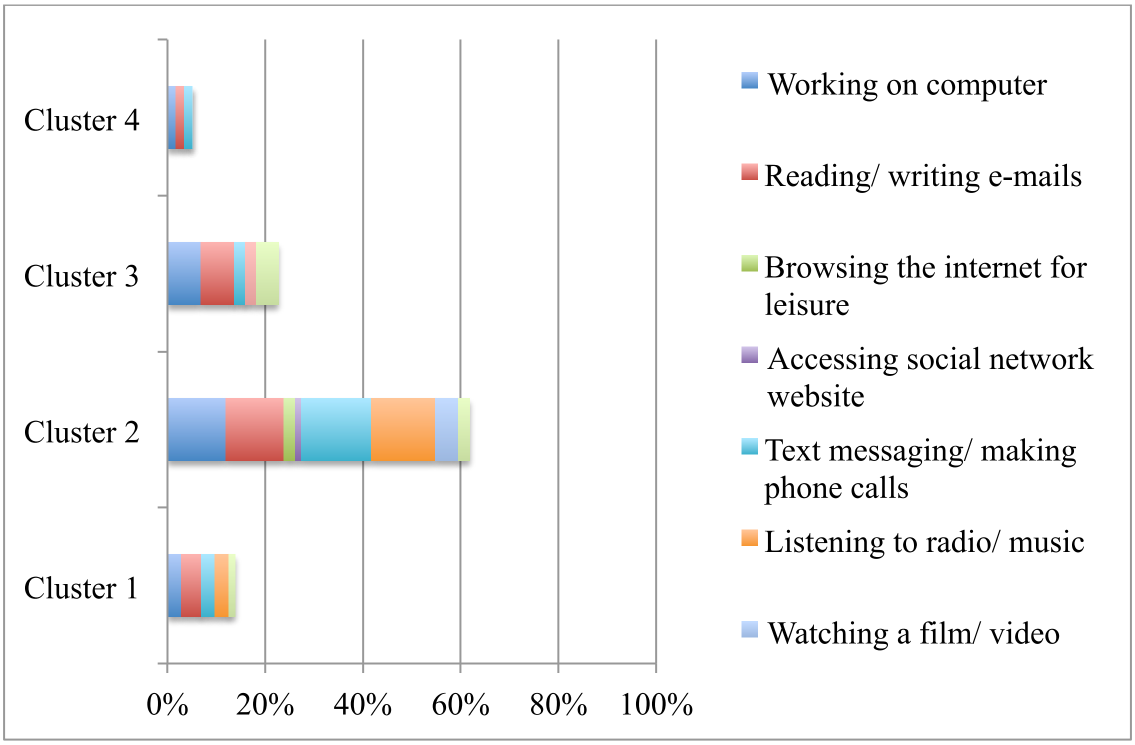



Figure 8.2 Proportion of EB in each cluster

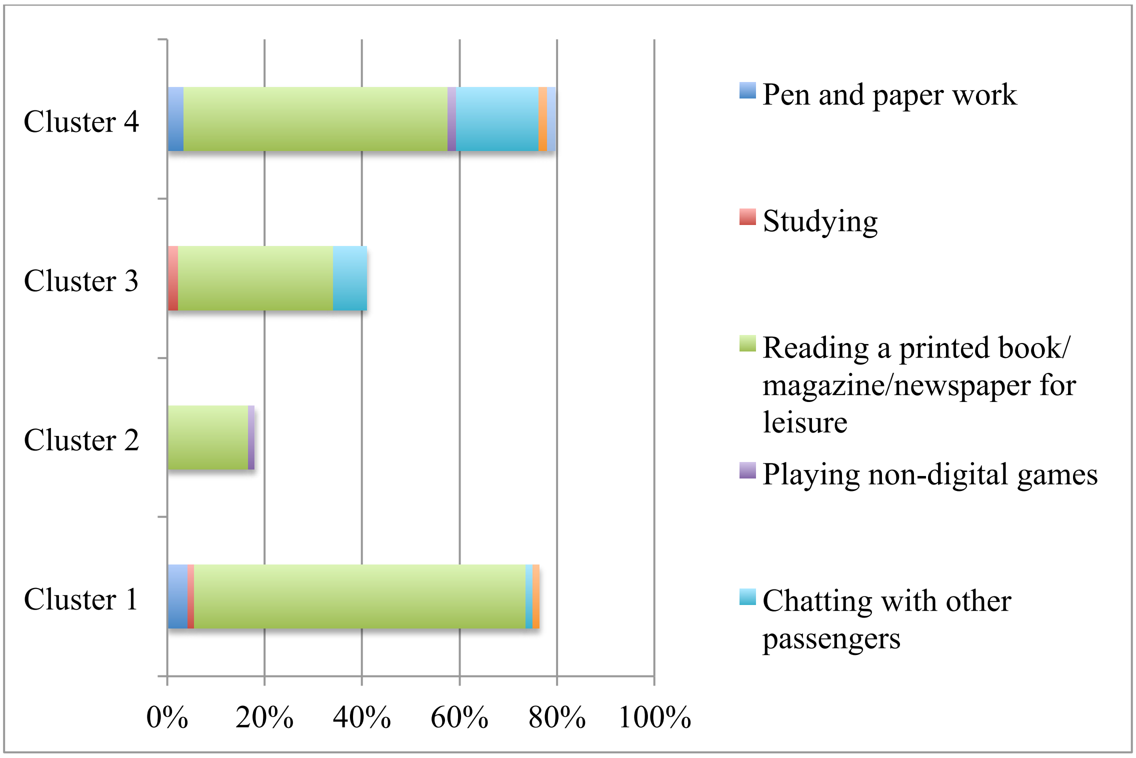



Figure 8.3 Proportion of NEB in each cluster

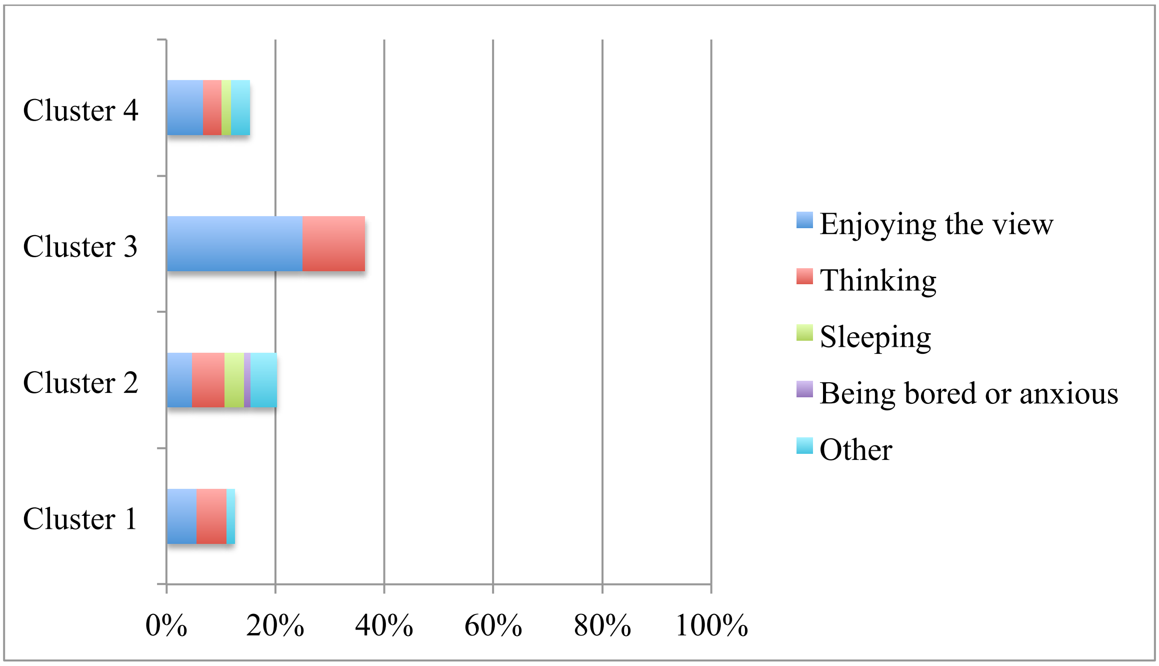



Figure 8.4 Proportion of PE in each cluster

## 8.3 Relationship Between the Perceived and Actual Travel Time by Clusters

As described earlier in this chapter, the aim of the cluster analysis in this study was to develop an understanding of whether the characteristics of the respondents governed the perceptions of time among different groups of respondents. There were four groups of respondents resulting from the cluster analysis. This section investigated whether the perceptions of time differed among the groups.

Figure 8.5 presents the distribution of samples across the four clusters identified. There are no obvious variations in the data distribution among the clusters. However, cluster 2 and 3 were more scattered and have more outliers than clusters 1 and 4. The relationship between the perceived and the actual travel time for each cluster was investigated using linear regression methods. The results are presented in Figure 8.6 and Table 8.4.

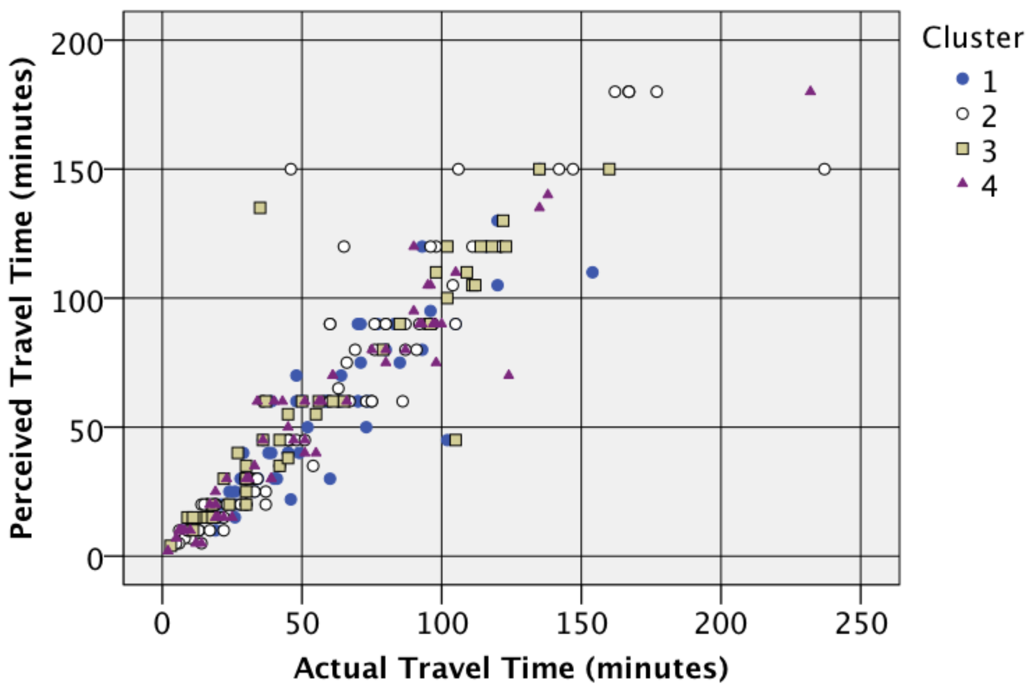



Figure 8.5 Superimposed scatterplot of perception of time data of the clusters

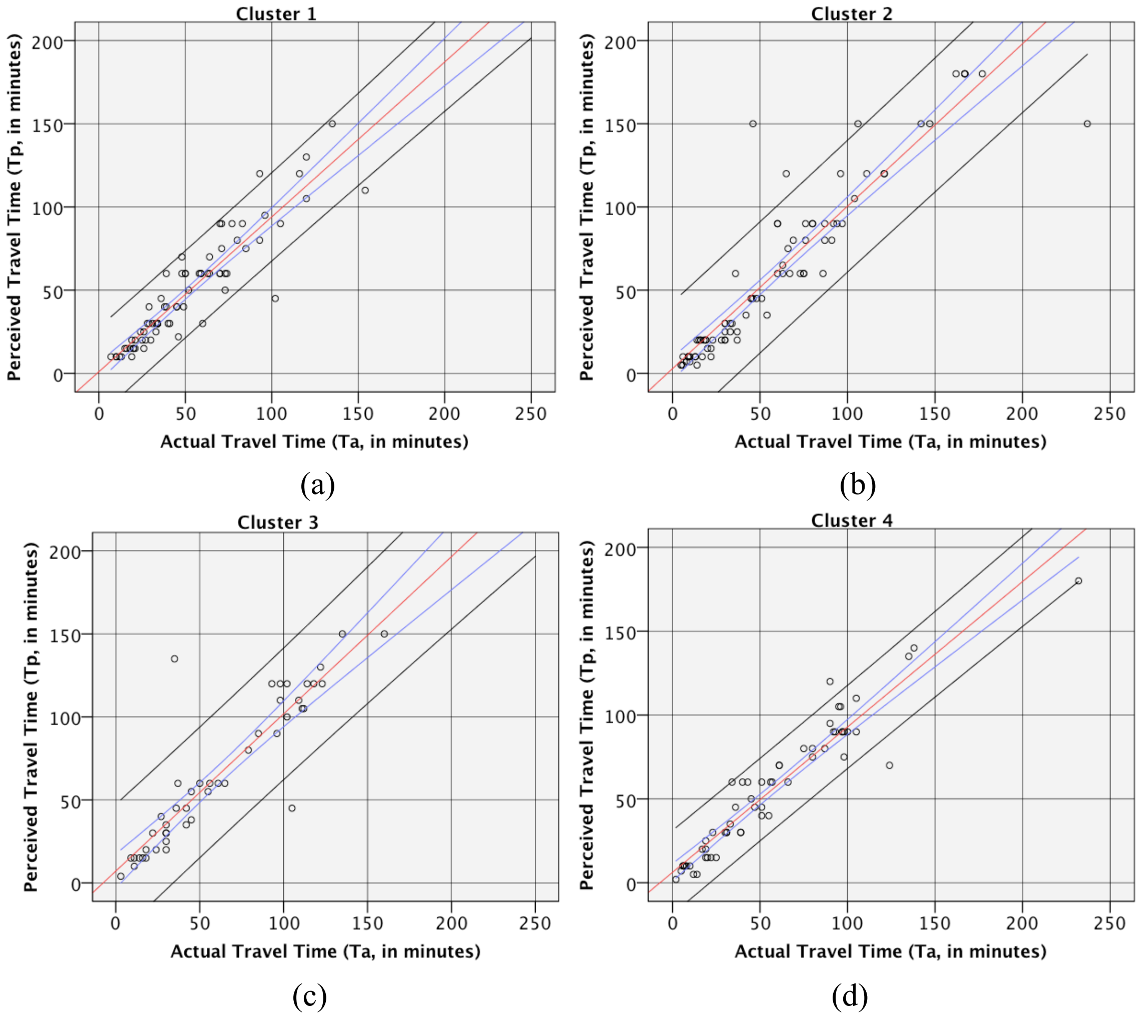



Figure 8.6 Scatterplot of averaged data by clusters; (a) Cluster 1, (b) Cluster 2, (c) Cluster 3, and (d) Cluster 4.

Table 8.3 Linear regression of the perceived and actual travel time by clusters

| Statistic | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| | **Intercept is set to zero** | **Intercept is not set to zero** | **Intercept is not set to zero** | **Intercept is not set to zero** |
| Intercept | NA | 3 | 7 | **6** ** |
| Slope | **0.95** ** | 0.98 | 0.93 | **0.87** ** |
| $R^2$ | 0.95 | 0.86 | 0.81 | 0.91 |
| df | 74 | 83 | 43 | 58 |
| Standard error of intercept (Sa) | NA | 3 | 5 | 3 |
| Standard error of slope (Sb) | 0.03 | 0.04 | 0.07 | 0.04 |

**Significant at the 95% level of confidence.
NA = not available as the intercept of the model is constrained to zero.

For each inset (a, b, c, and d) in Figure 8.6 for cluster 1, 2, 3, and 4 respectively the regression line along with the prediction and confidence intervals at the 95% level are shown. The t-test was used to examine the statistical significance of the difference of the intercept from zero and slope from one. When the intercept was not statistically significantly different from zero, the linear regression line was forced through zero. If the slope was still not statistically significantly from one, the linear regression selected without constraining to zero. The reason is because the regression line without being constrained to zero has lower standard errors.

With reference to Table 8.3, the results showed that the intercepts were not statistically significantly different from zero for all clusters except cluster 4, whilst the slopes were statistically significantly different from one for model cluster 1 and 4. The intercept was then constrained to zero for the clusters 1, 2 and 3. The results showed that the slopes were still not statistically significantly different from one for cluster 2 and cluster 3. Therefore, for those models, the intercept were retained.

The travel time was perceived as being 5% lower than actual by *frequently travelling mature males on business* (cluster 1). In comparison, *rarely travelling mature females on business* (cluster 4) perceived travel time as 13% lower than the actual travel time; however, there was a fixed penalty of 6 minutes for all journeys irrespective of duration. *Frequently travelling younger (male and female) employed on business* (cluster 2) and *rarely travel elderly male for leisure trip* (cluster 3) perceived travel time equal to the actual with no statistically significant fixed penalty. *Mature travellers on business* tend to perceive travel time as lower than the actual time suggesting that the business travellers were less aware of the passage of time. The reasons for this may be due to the fact that they were more focused on their job rather than the travel time on the train.

Further investigation was carried out using a crosstabs analysis to investigate whether the responsibility to pay the ticket price influences the perception of travel time and the results are given in Table 8.4.

Table 8.4 Ticket price responsiblity by clusters

| | **Proportion of Responders in each Cluster (%)** | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| Myself | 30 | 57 | 77 | 52 |
| My employer | 66 | 34 | 11 | 39 |
| Someone else | 3 | 5 | 7 | 7 |
| Other | 1 | 4 | 5 | 2 |

Table 8.4 shows that the ticket price for many in cluster 1 was paid by their employers. This suggested that a contributing factor to the perception of travel time being lower than the actual may be due to their journey being paid for by their employers. However, for those in cluster 4, about a half of them were responsible for the cost of their own journeys. This may suggest that the reason why the perceived travel time was lower than actual was because they consider their travel as their own time, and therefore, chose to spend most of time reading printed materials for pleasure. The existence of the 6 minutes penalty irrespective of the journey length suggested that the infrequent female travellers experienced anxiety of the need to travel which emerged as a fixed time penalty. This anxiety may be associated also with such components of the trip such as looking for a luggage rack or the need to find a booked seat. However, the questionnaire used in this study did not explore this but could be included in any further work.

The respondents in cluster 2 and 3 perceived travel time as being equal to the actual. The plots were highly scattered suggesting a wider variation in the awareness of time of younger persons on business and elderly males on leisure trips.

Given the similarity between cluster 1 and 4 and their dissimilarity to cluster 2 and 3, it can be inferred that the perceived travel time was influenced by age, employment status, main activity they pursued during the journey, and journey purpose. However, the outcome of the analysis does not support the prediction that the frequency of using train services and gender to influence the perception of time. For both frequent male and infrequent female travellers, the perceived travel time was found to be lower than the actual travel time although the slopes of the models were statistically significantly different.

## 8.4 Summary

The existence of dispersion revealed in the linear regression analysis presented in the previous chapter warranted further investigation to establish whether it was due to the socio-economic and journey specific characteristics of respondents. Therefore, the data was investigated further with cluster analysis. Four clusters emerged based on the variables of age, gender, employments status, main activity they pursued during the train journey, journey purpose and frequency with which they used the train service. Scrutiny of the characteristics of the group allowed descriptors for the clusters to be developed. Cluster 1 was mainly characterised by frequently travelled mature males on business, cluster 2 frequently travelled younger employed on business, cluster 3 infrequent elderly male travellers on leisure, cluster 4 infrequent mature females travellers on business. Notwithstanding these descriptors there was a high degree of overlap between the clusters.

The linear regression analysis suggests that the perception of time varied with respect to the four clusters developed. The frequent mature male travellers on business and the infrequent mature female travellers on business perceived travel time lower than the actual whilst the frequent younger travellers on business and the elderly male travelling for leisure perceived travel time as equal to the actual. Frequency of using train services and gender had less influence on the perception of time compared to other variables.

Based on the main activity, with regards to the overlapping between clusters, cluster analysis identified Cluster 1 and 4 as groups of travellers who engaged in NEB, whilst Cluster 2 as EB and Cluster 3 as PE group. The evidence showed that the perceived travel time of those who in Cluster 1 and 4 was lower than the actual time. On the other hand, those who in Cluster 2 perceived travel time lower than actual time whilst those who in Cluster 3 perceived travel time equal to the actual time. The evidence suggested that the main activity did influence the perception of time. People who engaged in reading printed materials or chatting perceived travel time to be quicker than actual, whilst those who engaged in working on the computer or reading/writing e-mails and those who spent time thinking or enjoying the view outside the windows perceived travel time as being equal to the actual.

# Chapter 9: How does Attitude Influence the Perception of Time?

## 9.1 Introduction

Cluster analysis successfully identified 4 groups of passengers that were found to have dissimilar perception of travel time. This chapter delves more deeply into the analysis of perception of travel time and attitudes to/ opinions of/ feelings towards train services in an attempt to investigate the relationship between them. Preliminary data analysis is presented first in Section 9.2, followed by the factor analysis conducted to identify the most important variables among a large set of variables in the dataset in Section 9.3. The relationship between the factors was identified through factor analysis and the perception of travel time will be discussed in Section 9.4 before summarising this chapter in Section 9.5.

## 9.2 Preliminary Data Analysis

First the entire dataset was analysed to investigate whether the data were normally distributed. A normality test showed that all of the data were statistically significantly different from normal distribution. Both Kolmogorov-Smirnov and Shapiro-Wilk tests showed that the difference was statistically significant at 99.99% level of confidence. Given the lack of normality of the distributions, Table 9.1 presents both the mean and median of the responses to the opinion, attitude, and feeling; however, instead of the mean, the median was used as a representation of the data.

Table 9.1 summarises the statistics derived for descriptive analysis and clearly shows that respondents agreed with the statements that they have the opportunity to work on the train (median = 6). Respondents also agreed that the journey time seemed to pass more quickly when using electronic devices (statement 1 with median = 6). Moreover, respondents showed their willingness to encourage people to use train services (statement 14 with median = 6). However, from four statements of the polychronic attitude index (statements 15, 16, 17 and 18 (section 5.2.3)), only statement 18 referring respondents to the comfort in doing more than one thing at a time was agreed as true (median = 6).

Table 9.1 Summary of descriptive analysis

| No. | Attitude | Descriptive Statistics* | | | |
|---|---|---|---|---|---|
| | | Median | Mean | St. Error of Mean | Standard Deviation |
| 1 | I have the opportunity to work during my journey today. | 6.00 | 5.77 | 0.09 | 1.55 |
| 2 | Working on the train is more productive than in the office. | 4.00 | 3.33 | 0.10 | 1.67 |
| 3 | The journey seems to pass more quickly when I am using my personal electronic devices, such as a laptop or iPhone. | 6.00 | 5.17 | 0.11 | 1.74 |
| 4 | Delays are less frustrating when free *Wi-Fi* is available on board | 4.00 | 4.44 | 0.12 | 2.04 |
| 5 | A small increase in travel time would be acceptable as long as free *Wi-Fi* is available on-board. | 4.00 | 3.46 | 0.13 | 2.07 |
| 6 | A small increase in the cost of the ticket would be acceptable as long as free *Wi-Fi* is available on-board. | 2.00 | 2.83 | 0.12 | 1.89 |
| 7 | The duration of this journey is too long. | 4.00 | 3.57 | 0.11 | 1.78 |
| 8 | This train is comfortable. | 5.00 | 5.28 | 0.08 | 1.34 |
| 9 | I worry about my personal safety when I travel by train. | 2.00 | 2.24 | 0.10 | 1.58 |
| 10 | Travelling by train makes me nervous. | 1.00 | 1.71 | 0.08 | 1.26 |
| 11 | Travelling by train is tiring. | 3.00 | 3.02 | 0.10 | 1.70 |
| 12 | I sometimes feel unwell when travelling by train. | 1.00 | 1.93 | 0.09 | 1.49 |
| 13 | I sometimes feel uncomfortable being around people I don't know on the train. | 2.00 | 2.19 | 0.10 | 1.57 |
| 14 | I would encourage people to use this train service. | 6.00 | 5.51 | 0.09 | 1.48 |
| 15 | I do not like to juggle several activities at the same time. | 4.00 | 3.43 | 0.11 | 1.80 |
| 16 | People should not try to do many things at once. | 4.00 | 3.47 | 0.11 | 1.79 |
| 17 | When I am at my office desk, I work on one project at a time. | 3.00 | 3.32 | 0.12 | 1.88 |
| 18 | I am comfortable doing several things at the same time. | 6.00 | 5.48 | 0.09 | 1.42 |

The data also showed that respondents disagreed with the statement that they would pay more as long as the Wi-Fi was available on a train (statement 6 with median = 2). Apart from statement 11 (median = 3), respondents expressed positive feelings towards travelling by exhibiting their disagreement to the statements 9, 10, 12, and 13 (median = 2, 1, 1 and 2 respectively).

More neutral/ambiguous responses were exhibited in responding to statement 2, 4, 5, 7, 8, 15, 16, and 17 as median of responses varied between 3 to 5. Standard deviations of the responses to those statements were found to range from 1.34 to 2.07 suggesting that the responses exhibited a wide distribution. In anticipation that the variation may be due to the activity, the data were analysed further to investigate whether different groups of respondents depending on the main activities exhibited different responses. This will be explored in the following section. Consistent with the earlier approach the analysis is first conducted on the grouping based on main activity and second defined by the cluster analysis.

### *9.2.1 Analysis based on main activity groups*

In this section, a comparison of the responses among the four groups of respondents segregated by main activities is presented. Pearson Chi-square two-sided significance test of the raw data was applied in the comparison. The median of the responses of the statements by the main activity groups and the level of significance are shown in Table 9.2.

Table 9.3 shows that the responses to the statements number 3, 4, 5, 6, 8 and 15 were significantly different among the groups at the 95% level of confidence whilst statements number 13 was significantly different at 90% level of confidence. Table 9.2 clearly shows that those who engage in EB compared to other groups were more likely to agree to the statements 3, 4, 5 and 6, which were related to the use of technology whilst travelling. It was surprising to find that those who engaged in NEB agreed that the journey seems to pass more quickly when using electronic devices. The question is why did they not choose to use EB activity during their journey if they realised that? Of course there may be several reasons, including that they did not have the electronic devices with them on the day of travel, or there may be a requirement to engage in pen and paper work or other non-electronic based activities. In contrast, it may be simply that they wanted to enjoy their travel experience and chose not to use any EB activities. However, the answer to these questions was outside of the scope of the questionnaire used in this research and no evidence was available to investigate this further. Responses to the statement number 6, despite being significantly different among the groups, most of respondents disagreed in paying more for access to Wi-Fi although 15 minutes duration was available free of charge at the time of the survey.

Table 9.2 Median of responses with respect to main activity groups

| No. | Attitude | Median | | | |
|---|---|---|---|---|---|
| | | EB | NEB | PE | Sig.[α] |
| 1 | I have the opportunity to work during my journey today. | 7.00 | 6.00 | 6.00 | 0.61 |
| 2 | Working on the train is more productive than in the office. | 4.00 | 3.00 | 4.00 | 0.86 |
| 3 | The journey seems to pass more quickly when I am using my personal electronic devices, such as a laptop or iPhone. | 6.00 | 5.00 | 4.00 | 0.00 |
| 4[β] | Delays are less frustrating when free *Wi-Fi* is available on board | 6.00 | 4.00 | 4.00 | 0.00 |
| 5[β] | A small increase in travel time would be acceptable as long as free *Wi-Fi* is available on-board. | 5.00 | 3.00 | 2.50 | 0.00 |
| 6[β] | A small increase in the cost of the ticket would be acceptable as long as free *Wi-Fi* is available on-board. | 3.00 | 2.00 | 2.50 | 0.00 |
| 7 | The duration of this journey is too long. | 4.00 | 4.00 | 4.00 | 0.79 |
| 8[β] | This train is comfortable. | 5.00 | 5.00 | 6.00 | 0.02 |
| 9 | I worry about my personal safety when I travel by train. | 1.00 | 2.00 | 2.00 | 0.52 |
| 10 | Travelling by train makes me nervous. | 1.00 | 1.00 | 1.00 | 0.17 |
| 11 | Travelling by train is tiring. | 3.00 | 3.00 | 3.00 | 0.45 |
| 12 | I sometimes feel unwell when travelling by train. | 1.00 | 1.00 | 1.00 | 0.21 |
| 13[ε] | I sometimes feel uncomfortable being around people I don't know on the train. | 1.00 | 2.00 | 1.00 | 0.07 |
| 14 | I would encourage people to use this train service. | 6.00 | 6.00 | 6.00 | 0.72 |
| 15[β] | I do not like to juggle several activities at the same time. | 4.00 | 3.00 | 4.00 | 0.04 |
| 16 | People should not try to do many things at once. | 4.00 | 3.00 | 4.00 | 0.47 |
| 17 | When I am at my office desk, I work on one project at a time. | 3.00 | 3.00 | 4.00 | 0.96 |
| 18 | I am comfortable doing several things at the same time. | 6.00 | 6.00 | 5.00 | 0.89 |

[α] Pearson Chi-square two-sided significance test of the raw data
[β] Significant at the 95% level of confidence
[ε] Significant at the 90% level of confidence

Negative responses received for the statement number 13 in all groups suggested that respondents did not feel uncomfortable being around people they do not know. More neutral responses were exhibited to the statement number 15 suggesting that sometimes they do and at other times they do not like to juggle several activities at the same time. However, as all of the statements 15 to 18 investigated the polychronic attitude index of the respondents, it was interesting to find that respondents exhibited more neutral responses to the negatively worded statements (statements number 15 and 16) than the positively worded statements such as statement 18. Statement number 17 was an ambiguous statement as discussed by Lindquist and Kaufman-Scarborough (2007). There was no difference in responses to other statements between the groups; therefore, these will not be discussed further in this section.

### *9.2.2 Analysis of Clusters*

In this section the responses of the respondents grouped by the cluster analysis are discussed. Consistent with the Section 9.5, the Pearson Chi-square two-sided significance test was used to test for statistically significant differences. The median of the responses of the statements by clusters and the level of statistical significances are shown in Table 9.4.

Recalling Section 8.2, the four clusters of travellers were as follows:

1. Frequent mature males on business.
2. Frequent young employed on business.
3. Infrequent elderly males for leisure.
4. Infrequent mature females on business.

Table 9.4 shows that the responses to the statements numbers 4, 5, 14, and 16 were statistically significantly different at the 95% level of confidence, whilst the responses to the statements, numbers 3, 11, and 15, were statistically significantly different at the 90% level of confidence among clusters. Respondents in cluster 3 were more likely to be neutral to the statement number 3 suggesting that this group of respondents were not familiar with/ do not use personal electronic devices, therefore this question is inappropriate. Delays seemed to be less frustrating to those in cluster 2 when free Wi-Fi is available on-board.

Table 9.4 The statistics based on cluster analysis

| **No.** | **Attitude** | **Median by Clusters** | | | | **Sig.** $^{\alpha}$ |
|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | |
| 1 | I have the opportunity to work during my journey today. | 6.00 | 6.00 | 6.00 | 6.00 | 0.72 |
| 2 | Working on the train is more productive than in the office. | 3.00 | 3.50 | 4.00 | 4.00 | 0.18 |
| 3 $^{\varepsilon}$ | The journey seems to pass more quickly when I am using my personal electronic devices, such as a laptop or iPhone. | 5.00 | 6.00 | 4.50 | 5.00 | 0.06 |
| 4 $^{\beta}$ | Delays are less frustrating when free *Wi-Fi* is available on board | 4.00 | 6.00 | 4.00 | 4.00 | 0.01 |
| 5 $^{\beta}$ | A small increase in travel time would be acceptable as long as free *Wi-Fi* is available on-board. | 3.00 | 4.00 | 2.50 | 3.00 | 0.00 |
| 6 | A small increase in the cost of the ticket would be acceptable as long as free *Wi-Fi* is available on-board. | 2.00 | 2.00 | 2.00 | 2.00 | 0.29 |
| 7 | The duration of this journey is too long. | 4.00 | 4.00 | 4.00 | 4.00 | 0.84 |
| 8 | This train is comfortable. | 5.00 | 6.00 | 5.50 | 6.00 | 0.25 |
| 9 | I worry about my personal safety when I travel by train. | 1.00 | 2.00 | 1.00 | 2.00 | 0.14 |
| 10 | Travelling by train makes me nervous. | 1.00 | 1.00 | 1.00 | 1.00 | 0.56 |
| 11 $^{\varepsilon}$ | Travelling by train is tiring. | 3.00 | 4.00 | 2.00 | 3.00 | 0.08 |
| 12 | I sometimes feel unwell when travelling by train. | 1.00 | 1.00 | 1.00 | 1.00 | 0.16 |
| 13 | I sometimes feel uncomfortable being around people I don't know on the train. | 2.00 | 1.00 | 1.00 | 2.00 | 0.85 |
| 14 $^{\beta}$ | I would encourage people to use this train service. | 5.00 | 6.00 | 6.00 | 6.00 | 0.04 |
| 15 $^{\varepsilon}$ | I do not like to juggle several activities at the same time. | 4.00 | 4.00 | 4.00 | 2.00 | 0.07 |
| 16 $^{\beta}$ | People should not try to do many things at once. | 4.00 | 3.00 | 4.00 | 2.00 | 0.00 |
| 17 | When I am at my office desk, I work on one project at a time. | 3.00 | 3.00 | 4.00 | 3.00 | 0.62 |
| 18 | I am comfortable doing several things at the same time. | 6.00 | 6.00 | 6.00 | 6.00 | 0.58 |

$^{\alpha}$ Pearson Chi-square two-sided significance test of the raw data
$^{\beta}$ Significant at the 95% level of confidence
$^{\varepsilon}$ Significant at the 90% level of confidence

Although the responses were slightly different among clusters, all of the respondents did not agree with the statements number 5 (increase in travel time is more acceptable if free Wi-Fi is available) and 11 (travelling by train is tiring) except those who in cluster 2 were more neutral. All groups preferred to encourage people to use the train; however, the preference of cluster 1 was not as strong as the others. All clusters except cluster 4 were indifferent to the statements number 15 (I do not like to juggle several activities) and 16 (people should not try to do many things at once); this suggests that women were more likely to enjoy multitasking.

## 9.3 Factor Analysis

Preliminary data analysis indicates that responses to some statements were similar within groups suggesting an "*overlap*" of some variables. Therefore, Factor Analysis (FA) was conducted to reduce the number of variables to be considered in the analysis. All responses received for the 18-statement list were entered as variables in to the factor analysis using SPSS version 19. The method of extraction selected was principal components analysis and the rotation was varimax. The principal components analysis (PCA) and varimax rotation were chosen because it is the most widely used FA documented in the literature (Kline, 1994) and recommended for data reduction (Moi and Sarstedt, 2011). The result of the analysis was compared to other techniques to assess the strength of the underlying constructs of the final solution. The factor score was saved as the variables for further analysis.

In order to assess the sufficiency of the variables for FA, an evaluation of the correlations matrix, KMO, variable-specific measures of sampling adequacy (MSA) on the diagonal of the anti-image correlation matrix were carried out. The correlation matrix revealed that each variable was statistically significantly correlated at the 95% level of confidence to at least seven others. The MSA scores varied in the range between 0.523 to 0.829, which were above the threshold value of 0.50 suggested by Moi and Sarstedt (2011). The Kaiser–Meyer–Olkin (KMO) was 0.724, which was referred as middling adequacy of correlation. Furthermore, the Bartlett's test of sphericity is significant ($p < 0.05$) and therefore FA is appropriate.

Table 9.4 Percentage of variance accounted

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 3.579 | 19.881 | 19.881 | 3.579 | 19.881 | 19.881 | 2.818 | 15.655 | 15.655 |
| 2 | 2.448 | 13.602 | 33.483 | 2.448 | 13.602 | 33.483 | 2.424 | 13.465 | 29.120 |
| 3 | 1.928 | 10.714 | 44.197 | 1.928 | 10.714 | 44.197 | 2.289 | 12.718 | 41.838 |
| 4 | 1.247 | 6.927 | 51.124 | 1.247 | 6.927 | 51.124 | 1.429 | 7.938 | 49.776 |
| 5 | 1.156 | 6.425 | 57.549 | 1.156 | 6.425 | 57.549 | 1.303 | 7.239 | 57.015 |
| 6 | 1.095 | 6.082 | 63.631 | 1.095 | 6.082 | 63.631 | 1.191 | 6.616 | 63.631 |
| 7 | .913 | 5.071 | 68.702 | | | | | | |
| 8 | .801 | 4.452 | 73.154 | | | | | | |
| 9 | .740 | 4.113 | 77.267 | | | | | | |
| 10 | .694 | 3.853 | 81.120 | | | | | | |
| 11 | .593 | 3.294 | 84.414 | | | | | | |
| 12 | .571 | 3.175 | 87.589 | | | | | | |
| 13 | .452 | 2.513 | 90.102 | | | | | | |
| 14 | .439 | 2.441 | 92.543 | | | | | | |
| 15 | .407 | 2.260 | 94.803 | | | | | | |
| 16 | .360 | 2.002 | 96.805 | | | | | | |
| 17 | .335 | 1.860 | 98.665 | | | | | | |
| 18 | .240 | 1.335 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

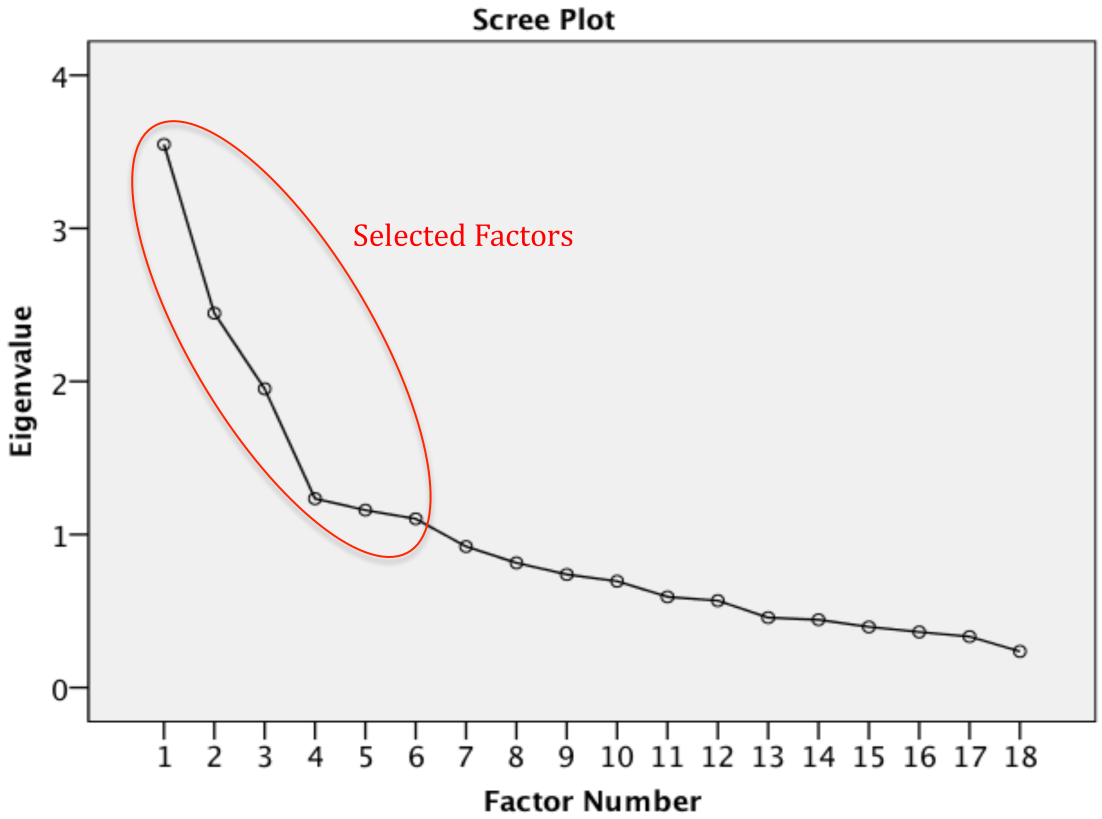



Figure 9.1 Scree plot of PCA with the selected factors in oval shape

The decision on the number of factors extracted was based on the Kaiser Criterion, where all components with eigenvalues under 1.0 were dropped (Kaiser, 1960) and the scree plot (Cattell, 1966). The eigenvalue larger than a 1.0 approach revealed extraction of 6 factors, which accounted for 64% of variance as shown in Table 9.4. The scree plot shown in Figure 9.1 revealed that the eigenvalues drop largely on the first three factors and an elbow formed at the fourth suggesting extraction of three factors. However, extraction of the three factors only accounted for 44% of the variance and obtained larger redundant residuals (52%). Another elbow is formed at the 7th factors suggesting extraction of six factors, and this is similar to the result of the Kaiser Criterion approach. Therefore, six factors were selected for this study.

Both of these methods, the scree plot and the eigenvalues indicated that the number of factors to extract was 6 factors and accounted for 63.7% of the total variance in the data set and as such 37.3% of the variance was not extracted. Factor 1 to 6 accounted for 19.88%, 13.60%, 10.71%, 6.93%, 6.42%, and 6.08% of the variance respectively with eigenvalues greater than 1.0. The communalities scores and factor-loading of the final solution of the FA is shown in Table 9.6. The communality values varied in the range of 0.460 to 0.720. The high scores of communalities and factor loadings suggested a good model fit to the data and indicated a strong internal stability.

Comparison of the PCA result with other extraction methods such as unweighted least squares, generalised least squares, and image factoring, revealed similar factor loading patterns with extraction of 6 factors suggesting that strong underlying constructs within the data were present. However, the total accounted variances of the extracted factors obtained from those techniques were lower than the PCA. Conversely, principal axis factoring (PAF), maximum likelihood, and alpha factoring could not extract any factors because the communality of a variable is exceeded 1.0. In term of the rotation methods, oblique rotation methods revealed that none of the factors were statistically significantly correlated (>0.30). Therefore, the use of varimax was justified.

Table 9.5 The factor solution

| Factors | St. Number | Components | Communality | Factor loading |
|---|---|---|---|---|
| Factor 1 | 9 | I worry about my personal safety when I travel by train. | 0.649 | 0.772 |
| | 10 | Travelling by train makes me nervous. | 0.644 | 0.745 |
| | 11 | Travelling by train is tiring. | 0.526 | 0.633 |
| | 12 | I sometimes feel unwell when travelling by train. | 0.643 | 0.780 |
| | 13 | I sometimes feel uncomfortable being around people I don't know on the train. | 0.552 | 0.724 |
| Factor 2 | 15 | I do not like to juggle several activities at the same time. | 0.721 | 0.839 |
| | 16 | People should not try to do many things at once. | 0.670 | 0.806 |
| | 17 | When I am at my office desk, I work on one project at a time. | 0.460 | 0.612 |
| | 18 | I am comfortable doing several things at the same time. | 0.650 | -0.762 |
| Factor 3 | 3[a] | The journey seems to pass more quickly when I am using my personal electronic devices, such as a laptop or iPhone. | 0.628 | 0.525 |
| | 4 | Delays are less frustrating when free *Wi-Fi* is available on board | 0.687 | 0.778 |
| | 5 | A small increase in travel time would be acceptable as long as free *Wi-Fi* is available on-board. | 0.825 | 0.892 |
| | 6 | A small increase in the cost of the ticket would be acceptable as long as free *Wi-Fi* is available on-board. | 0.641 | 0.725 |
| Factor 4 | 8 | This train is comfortable. | 0.667 | 0.814 |
| | 14 | I would encourage people to use this train service. | 0.590 | 0.718 |
| Factor 5 | 1 | I have the opportunity to work during my journey today. | 0.552 | 0.645 |
| | 2 | Working on the train is more productive than in the office. | 0.712 | 0.816 |
| Factor 6 | 7 | The duration of this journey is too long. | 0.649 | 0.735 |

[a] A cross factor loading revealed among the 3rd and the 6th factor (0.525 and 0.504 respectively) in statement 3.

Using the highest absolute factor loadings, each variable was assigned to a certain factor and then a label was assigned to describe the collective characteristics of all variables associated with each. These were as follows:

1. Factor 1: Personal feeling
2. Factor 2: Multitasking ability
3. Factor 3: Technology effect
4. Factor 4: Train comfort potential
5. Factor 5: Productivity
6. Factor 6: Journey duration

There is a degree of consistency in the results of the factor analysis and the descriptive analysis in the sense that factor 1 confirmed the observation in Section 9.2 that numbers 9, 10, 11, 12, and 13 were similar. Subsequently, in terms of multitasking ability, consistent with the results in the Section 9.2, the items number 15, 16, 17 and 18, were also similar and grouped as factor 2.

## 9.4 Relationship Between Attitude and Perception of Travel Time

Given that there were fewer factors to consider in the analysis; attempts were then made to assess the relationship between attitude and perception of travel time. This was achieved by introducing a new variable named ratio of perceived and actual travel time (RPA).

$$RPA = \frac{T_p}{T_a} \quad \text{(9.1)}$$

Where:

$T_p$ is the perceived travel time.

$T_a$ is the actual travel time.

Since the RPA is a ratio between the perceived and the actual travel time, the increment of its values reflecting the increment of the perceive time. Travel time was perceived shorter or longer than actual time if $RPA$ is less or more than 1 respectively.

A relationship between the factors and the RPA was assessed using Spearman's correlation analysis. Components with the highest factor loading, the sum of components scores, and factor scores from the factor analysis were used as a representation of each of the factors. Therefore, three correlation analyses were carried out and the results are presented in Table 9.6, 9.7 and 9.8.

Table 9.6 Spearman's correlation between RPA and factors represented by components with highest factor loading (N = 264)

| Factor | Statements | Correlation Coefficient | Sig. (2-tailed) |
|---|---|---|---|
| Factor 1 | I sometimes feel unwell when travelling by train | -0.01 | 0.82 |
| Factor 2 | I do not like to juggle several activities at the same time | -0.05 | 0.44 |
| Factor 3 | A small increase in travel time would be acceptable as long as free Wi-Fi is available on-board | 0.09 | 0.14 |
| Factor 4 | This train is comfortable | -0.09 | 0.13 |
| Factor 5 | Working on the train is more productive than in the office | 0.07 | 0.28 |
| **Factor 6** | **The duration of this journey is too long** | **0.11** ** | **0.09** ** |

**Statistically significant at the 90% level of confidence

Table 9.6 reveals that factor 6 which is represented by items number 7 (The duration of this journey is too long) is statistically significantly correlated with the RPA in a positive way suggesting that the RPA increased with an increase in the score of the item number 7. Therefore, there was evidence that the perceived travel time increased when travellers felt that the journey duration is too long, however, the correlation is very weak as the coefficient lower than 0.50.

When the sum of the components scores were used as a representation of the factors, in addition to factor 6, factor 3 is also statistically significantly correlated with RPA at the 90% level of confidence in a positive way as shown in Table 9.7. However, similar to the result in Table 9.6, small coefficient correlations suggested that the correlation was weak.

Table 9.7 Spearman's correlation between RPA and factors represented by sum of the scores of each factor (N = 264)

| Factor | Label | Correlation Coefficient | Sig. (2-tailed) |
|---|---|---|---|
| Factor 1 | Personal feeling | -0.01 | 0.89 |
| Factor 2 | Multitasking ability | -0.04 | 0.50 |
| **Factor 3** | **Technology effect** | **0.10** *** | **0.09** *** |
| Factor 4 | Train comfort potential | -0.10 | 0.10 |
| Factor 5 | Productivity | 0.06 | 0.32 |
| **Factor 6** | **Journey duration** | **0.11** *** | **0.09** *** |

***Statistically significant at the 90% level of confidence

The result of the Spearman's correlation of RPA and factor scores given in Table 9.8 demonstrates only two factors that are statistically significant. Factor 3 which positively correlated with RPA, whilst factor 4 was negatively correlated. Both of these correlations were significant at the 90% level of confidence. All other factors were not significantly correlated with RPA. These results indicated that the use of technology and train comfort was affecting the perception of time in a positive and negative way respectively. However, similar to the other results in Table 9.6 and 9.7, the correlations are too weak to justify those relationships.

Table 9.8 Spearman's correlation between RPA and factor scores

| Factor | Label | Correlation Coefficient | Sig. (2-tailed) |
|---|---|---|---|
| Factor 1 | Personal feeling | -0.01 | 0.90 |
| Factor 2 | Multitasking ability | -0.01 | 0.88 |
| **Factor 3** | **Technology effect** | **0.11** ** | **0.09** ** |
| **Factor 4** | **Train comfort potential** | **-0.11** ** | **0.07** ** |
| Factor 5 | Productivity | 0.10 | 0.11 |
| Factor 6 | Journey duration | 0.04 | 0.53 |

**Statistically significant at 90% level of confidence

The correlations analyses of the data altogether appeared to suggest that there was a weak correlation between the attitudes/opinion/feeling (represented by the 6 factors) and the perception of travel time (represented by RPA). The preliminary analysis presented in Section 9.2 suggested that some responses were statistically significantly different among groups of respondents such as the main activity group and socio-demographic cluster. Therefore, further analyses were conducted to investigate the relationship between the RPA and the factors for segregated data by the main activity group and socio-demographic clusters. These analyses are presented in Section 9.4.1 and 9.4.2.

### *9.4.1 Relationship between attitude and perception of travel time by main activity groups*

In this section, the Spearman's correlation was used to investigate whether there were correlations between the factor scores and the RPA. The results shown in Table 9.9 reveals that there was one factor only in each model that was statistically significantly correlated with RPA namely factor 3 in EB, factor 4 in NEB and factor 5 in PE model as pointed in bold number with a star symbol explaining its significance level. The coefficients of the factor that was significantly correlated in these analyses are higher than in those presented earlier in Section 9.4, however, the correlations are not strong enough (lower than absolute 0.50). The improvement of the coefficient correlation suggests that the correlation existed but other factors may have a stronger influence on the relationship. In order to assess whether the socio-demographic cluster influenced the relationship between the factor of attitude/opinion and feeling and the perception of travel time, further analysis was carried out and presented in Section 9.4.2.

Table 9.9 Spearman's correlations between RPA and factors for EB, NEB and PE.

| Factor | Label | Main Activity | | |
|---|---|---|---|---|
| | | **EB** | **NEB** | **PE** |
| Factor was represented by component with highest factor loading | | | | |
| Factor 1 | Personal feeling | -0.13 | 0.08 | -0.02 |
| Factor 2 | Multitasking ability | -0.05 | 0.00 | 0.11 |
| Factor 3 | Technology effect | **0.20** ** | 0.04 | 0.20 |
| Factor 4 | Train comfort potential | -0.07 | -0.10 | -0.06 |
| Factor 5 | Productivity | -0.07 | 0.05 | **0.34** * |
| Factor 6 | Journey duration | 0.13 | 0.10 | 0.20 |
| Factor was represented by sum of components score | | | | |
| Factor 1 | Personal feeling | 0.04 | 0.03 | -0.08 |
| Factor 2 | Multitasking ability | -0.03 | -0.01 | 0.17 |
| Factor 3 | Technology effect | **-0.27** * | 0.05 | 0.08 |
| Factor 4 | Train comfort potential | 0.02 | **-0.15** ** | -0.07 |
| Factor 5 | Productivity | -0.05 | 0.04 | **0.32** ** |
| Factor 6 | Journey duration | 0.13 | 0.10 | 0.20 |
| Factor was represented by factor score | | | | |
| Factor 1 | Personal feeling | -0.06 | 0.05 | -0.12 |
| Factor 2 | Multitasking ability | -0.05 | -0.03 | 0.16 |
| Factor 3 | Technology effect | **0.29** * | 0.04 | 0.09 |
| Factor 4 | Train comfort potential | -0.02 | **-0.16** ** | -0.16 |
| Factor 5 | Productivity | -0.08 | 0.10 | **0.34** * |
| Factor 6 | Journey duration | 0.05 | 0.03 | 0.18 |

* Statistically significant data at the 95% level of confidence
** Statistically significant data at the 90% level of confidence

### *9.4.2 Relationship between attitude and perception of travel time by clusters*

In order to investigate whether the factors and the RPA by groups of respondents were significantly correlated, a Spearman's correlation test was conducted for each of the clusters discussed in Chapter 8. The evaluation test results shown in Table 9.10 revealed that the correlations were not statistically significance between the factors and RPA for all clusters except those which were written in bold numbers and given a star symbol to explain their level of significance. However, similar to the results of analyses presented earlier in Section 9.4.1, none of these correlations were strong (>0.50).

Table 9.10 Spearman's correlations between RPA and factors for clustered data

| Factor | Label | Cluster | | | |
|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** |
| Factor was represented by component with highest factor loading | | | | | |
| Factor 1 | Personal feeling | 0.06 | -0.17 | 0.25 | -0.02 |
| Factor 2 | Multitasking ability | 0.00 | 0.07 | -0.21 | 0.12 |
| Factor 3 | Technology effect | -0.01 | 0.18 | 0.19 | 0.10 |
| Factor 4 | Train comfort potential | -0.03 | -0.04 | -0.05 | -0.20 |
| Factor 5 | Productivity | 0.07 | 0.07 | 0.09 | -0.01 |
| Factor 6 | Journey duration | 0.07 | **0.20** ** | -0.05 | 0.10 |
| Factor was represented by sum of components score | | | | | |
| Factor 1 | Personal feeling | 0.06 | -0.17 | 0.20 | -0.07 |
| Factor 2 | Multitasking ability | -0.06 | 0.07 | -0.16 | 0.11 |
| Factor 3 | Technology effect | 0.05 | 0.15 | 0.18 | 0.11 |
| Factor 4 | Train comfort potential | **-0.23** * | -0.03 | -0.05 | -0.15 |
| Factor 5 | Productivity | 0.04 | 0.07 | 0.14 | 0.13 |
| Factor 6 | Journey duration | 0.07 | **0.20** ** | -0.05 | 0.10 |
| Factor was represented by factor score | | | | | |
| Factor 1 | Personal feeling | 0.07 | **-0.22** * | **0.26** ** | -0.09 |
| Factor 2 | Multitasking ability | -0.09 | 0.08 | -0.19 | 0.08 |
| Factor 3 | Technology effect | 0.04 | 0.15 | 0.20 | 0.08 |
| Factor 4 | Train comfort potential | -0.19 | -0.09 | -0.11 | -0.19 |
| Factor 5 | Productivity | 0.04 | 0.03 | 0.15 | 0.14 |
| Factor 6 | Journey duration | 0.07 | 0.13 | -0.06 | 0.00 |

* Statistically significant data at the 95% level of confidence
** Statistically significant data at the 90% level of confidence

## 9.5 Summary

An analysis of the relationship between the attitude to train services and the perception of time was reported in this chapter. In the regression, the 6 factors resulted from factor analysis and the ratio of the perceived and actual travel time (RPA) were used as variables.

Before conducting the regression, a descriptive analysis was conducted to examine the data distribution. Most of the respondents either strongly agreed or strongly disagreed with the statements presented to them. The data showed that most of respondents agreed that they have an opportunity to work on train. Respondents also agreed that journey time seemed to pass more quickly when they are using electronic devices. However, more than half of respondents were not prepared to pay the additional cost for the Wi-Fi services on board. This finding suggests that the Wi-Fi service provided on the train was not a major influence on passengers, either because they have their own connection to the Internet on a smart phone or a mobile broadband device.

Most of respondents did not exhibit negative feelings about train services. Furthermore, most of respondents suggested that they would encourage people to use train services and felt comfortable in a public environment surrounded by unfamiliar people.

Aggregation of variables using factor analysis extracted 6 factors which were labelled personal feeling, multitasking ability, technology effect, train comfort potential, productivity, and journey duration. The regression analysis of the factors solutions revealed that most of the factors were found not to be correlated with the perception of time. When all data of the respondents were used, despite not being so strong, the factor of the effect of technology was positively correlated with the ratio of the perceived and actual travel time. This infers that the use of technology increases the perception of time.

As discussed earlier in Chapter 7, the perception of time was higher when using technology was associated with productivity. When productivity was high, the perceived travel time was high. On the other hand, the factor related to train comfort potential was negatively correlated with the ratio of the perceived and actual travel time. The negative correlation inferred that when the comfort of the train was high, the perception of time was lower. Travel time passing more quickly when the train is comfortable has emerged from previous studies including Lyons *et al.* (2007) and Ettema and Verschuren (2007).

When the respondents were disaggregated by clusters and by main activity groups, the correlation between the majority of factor scores and the RPA were not significant for all clusters and activity groups.  However as expected significant correlations between particular factors with some selected clusters and/or main activity groups were clearly evident, for example, the effect of technology on EB, train comfort in NEB, and productivity in PE. It should be noted that a lack of statistical significant at the cluster level of analysis is due in part to the lower sample size in this disaggregated level.

# Chapter 10: Analysis of Value of Time

## 10. 1 Introduction

Previous chapter revealed that the relationship between the perception of time and the attitude towards and opinions of the service whilst travelling vary depending on the cluster of socio demographic and main activity of passengers. This chapter conducts an in depth investigation of value of time (VOT) using Discrete Choice Analysis (DCA) to investigate the influence of the socio demographic clusters and main activity. As the time measured in this study is spent on train journeys, the estimated VOT is the value of travel time in monetary terms.

The preparation of the data set will be discussed in Section 10.2 and followed by the analysis of the entire data using DCA in Section 10.3. As the data showed the existence of some non-trading responses, the DCA applied to the group of individuals who do not belong to the non-trading category is discussed in Section 10.4. Non-trading behaviours in this study refers to the situation where a respondent always chooses the same alternative across the choice set (Hess *et al.*, 2010). Section 10.5 discusses the application of DCA for separated data of the first and standard class respondents. The relationship between the perception of time and VOT with respect to main activity of passengers whilst travelling is discussed in Section 10.6. Finally, conclusion will be drawn from the results and discussion in Section 10.7.

## 10. 2 Data Preparation

In this section, data preparation for the DCA is discussed. NLOGIT software was selected for analysing data because this software was available to use at the time when this study was conducted and it claimed to be the most popular software package (Hensher *et al.*, 2005). Data was initially prepared in a Microsoft Excel spreadsheet using a single-line format (as shown in Table 10.1) and later transported into a multi-line format (as shown in Table 10.2). Single-line data means that each scenario was written in a single line, whilst multi-lines data means each scenario was written in several lines depending on the number of alternatives involved.

In the SP survey, each respondent was provided with eight scenarios altogether and each of them consisted of three alternatives namely Alternative 1 (*Same*), Alternative 2 (*MCLT*) and Alternative 3 (*LCMT*) as discussed in Chapter 4 Section 4.8 and Chapter 5 Section 5.2. Alternative *same* was an option where travel time and cost were not changed over the journey being made at the time the survey was conducted. Alternative *MCLT* was faster but more expensive, whilst *LCMT* was less expensive but slower compared to current journey. An identification number (ID) was assigned to each scenario as shown in Table 10.1. There were two attributes, travel time and travel cost, used to define the alternatives. Travel cost variables for each alternative were C(*Same*), C(*MCLT*) and C(*LCMT*). Similarly travel time variables for each alternative were defined as T(*Same*), T(*MCLT*) and T(*LCMT*). The alternative that was chosen by the respondents for each scenario was indicated in the last column of Table 10.1.

Table 10.1 Example of a single-line data set (the shaded row is not part of the data input)

| | **Alternative 1 (Same)** | | **Alternative 2 (MCLT)** | | **Alternative 3 (LCMT)** | | |
|---|---|---|---|---|---|---|---|
| **ID** | **C (Same)** | **T (Same)** | **C (MCLT)** | **T (MCLT)** | **C (LCMT)** | **T (LCMT)** | **Choice*** |
| 1 | 52 | 57 | 45 | 102 | 82 | 128 | 2 |
| 2 | 52 | 57 | 42 | 99 | 86 | 106 | 2 |
| 3 | 52 | 59 | 49 | 108 | 101 | 134 | 2 |
| 4 | 52 | 57 | 49 | 106 | 99 | 119 | 2 |
| 5 | 52 | 62 | 47 | 109 | 96 | 116 | 3 |
| 6 | 52 | 62 | 47 | 109 | 89 | 129 | 2 |
| 7 | 52 | 59 | 42 | 101 | 81 | 114 | 2 |
| 8 | 52 | 59 | 42 | 101 | 88 | 108 | 3 |

*Note: Choice = 1 (the respondent selected alternative 1 (Same)
Choice = 2 (the respondent selected alternative 2 (MCLT)
Choice = 3 (the respondent selected alternative 3 (LCMT)

Variable CSET in Table 10.2 was designed to inform NLOGIT of the number of alternatives within a particular choice set (Hensher *et al.*, 2005). In this study, all respondents received the same choice set; therefore the choice set was fixed to 3 alternatives as discussed above. However, in a RP study, CSET does not have to be a fixed size but depends on the number of alternatives available given that some alternatives may not present at the specific time and location of the data collection survey.

Table 10.2 Example of multi-line data set.

| ID | ALT | CSET | CHOICE | COST | TIME |
|---|---|---|---|---|---|
| 1 | 1 | 3 | 0 | 52 | 102 |
| 1 | 2 | 3 | 1 | 57 | 82 |
| 1 | 3 | 3 | 0 | 45 | 128 |
| 2 | 1 | 3 | 0 | 52 | 99 |
| 2 | 2 | 3 | 1 | 57 | 86 |
| 2 | 3 | 3 | 0 | 42 | 106 |
| 3 | 1 | 3 | 0 | 52 | 108 |
| 3 | 2 | 3 | 1 | 59 | 101 |
| 3 | 3 | 3 | 0 | 49 | 134 |
| 4 | 1 | 3 | 0 | 52 | 106 |
| 4 | 2 | 3 | 1 | 57 | 99 |
| 4 | 3 | 3 | 0 | 49 | 119 |
| 5 | 1 | 3 | 0 | 52 | 109 |
| 5 | 2 | 3 | 0 | 62 | 96 |
| 5 | 3 | 3 | 1 | 47 | 116 |
| 6 | 1 | 3 | 0 | 52 | 109 |
| 6 | 2 | 3 | 1 | 62 | 89 |
| 6 | 3 | 3 | 0 | 47 | 129 |
| 7 | 1 | 3 | 0 | 52 | 101 |
| 7 | 2 | 3 | 1 | 59 | 81 |
| 7 | 3 | 3 | 0 | 42 | 114 |
| 8 | 1 | 3 | 0 | 52 | 101 |
| 8 | 2 | 3 | 0 | 59 | 88 |
| 8 | 3 | 3 | 1 | 42 | 108 |

## 10. 3 Discrete Choice Analysis (DCA) of Entire Data Set

DCA of the entire SP data set is discussed in this section. As discussed in Chapter 4 Section 4.8, the Multinomial Logit (MNL) Model was used to analyse the data. The analysis was conducted first by having the complete set and secondly by segregating the data in accordance with a) clusters and b) main activity groups.

In this study, the analysis was limited to the generic variables, travel time and cost only. The inclusion of socio-demographic data in the model would have been useful; however, this cannot be achieved without generating the interaction terms with both time and cost (Hensher *et al.*, 2005). Even though it is not possible to explore socio-demographic variables directly in this DCA, to some extent they have already been considered when generating the clusters. Therefore data segregated by cluster analysis was modelled using DCA. The specification of the model for this study therefore is as follows:

$$U = \beta_t(Time) + \beta_c(Cost) \quad (10.4)$$

Where:

$U$ : Utility
$\beta_t$ : Parameter associated with attribute *Time*
$\beta_c$ : Parameter associated with attribute *Cost*
*Time* : Travel time
*Cost* : Travel cost

### *10.3.1 Estimation of Multinomial Logit (MNL) model for the complete dataset*

A MNL model was derived by taking into account the complete set of data collected from the survey consisting of 210 samples. The three choice alternatives namely *same*, *MCLT* and *LCMT* were considered as unlabelled alternatives with generic variables. The result of the analysis shown in Table 10.3 indicates that both parameters of *cost* and *time* are statistically significant at the 95% level of confidence.

Table 10.3 The MNL model for the complete set of data

| Attributes | Coefficient | t-value** |
|---|---|---|
| Cost | **-0.0184** * | -4.531 |
| Time | **-0.0195** * | -9.472 |
| $\rho^2$ | 0.02 | |
| Log likelihood | -1788.42 | |
| Number of observations | 1680 | |

* Statistically significant at the 95% level of confidence.
**t-value = b/St. error where b is parameter and St. Error is standard error of variable.

Table 10.3 shows that both signs of the model coefficients are negative suggesting that the utility decreases when the travel cost or travel time increase. The probability of choosing an alternative decreases when the utility decreases, therefore the higher travel cost (or travel time) will reduce the probability of an alternative being chosen.

Table 10.3 shows that both coefficient of the model are significant at 95% level of confidence. However, the rho-square of the model is considered as small, even though the rho-square in the MNL model is not the same with that in linear regression model. According to Louviere *et al*. (2000) the rho-square between 0.2 and 0.4 represent a decent model fit in MNL, whilst in Hensher et al (205) the rho-square has a higher value between 0.3 and 0.4. Hensher *et al*. (2005) also suggested that the use of more variables such as socio-economic data in the model might produce more decent model fit. However, considering the objective of this study to compare the VOT between groups of respondents, and the alternatives in the choice experiment were considered as 'unlabelled', the used of variable cost and time are maintained.

The result from the DCA, presented in Table 10.3, was used to generate the VOT. As shown in equation 3.9 in Chapter 3, the VOT was calculated using the ratio of travel time and cost parameters as follows:

$$VOT = \left(\frac{£}{min}\right)\left(\frac{-0.0195}{-0.0184}\right) = £1.06/_{min} = £63.60/_{hour} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(10.5)}$$

Compared to the findings of Tapley (2008) and Wardman (2004), the VOT found in this study was much higher than it was for the standard class but much lower than that for the 1$^{st}$ class passengers. The differences may be due to the fact that the VOT calculated in this analysis was for all respondents.

### *10.3.2 Estimation of Multinomial Logit (MNL) models for clustered data*

Four MNL models were developed for the four clusters drawn from the data in Chapter 8 defined as follows:

Cluster 1: Frequently travelled mature males on business
Cluster 2: Frequently travelled younger persons employed on business
Cluster 3: Infrequently travelled elderly males for leisure
Cluster 4: Infrequently travelled mature females on business

The estimation of separate models for each cluster is important as any differences in the VOT between different clusters drawn from the main dataset will emerge enhancing our knowledge and better informing operations decisions regarding potential marketing and pricing strategies for different groups of travellers in our society. The results are presented in Table 10.4.

Table 10.4 The MNL models for clustered data (t-values are in the brackets)

| Attributes | Coefficients (Cluster 1) | Coefficients (Cluster 2) | Coefficients (Cluster 3) | Coefficients (Cluster 4) |
|---|---|---|---|---|
| Cost | **-0.024 (-3.386)** | -0.004 (-0.617) | **-0.051 (-3.695)** | **-0.026 (-2.669)** |
| Time | **-0.028 (-6.456)** | **-0.013 (-4.238)** | **-0.028 (-5.160)** | **-0.020 (-3.615)** |
| $\rho^2$ | 0.03 | -0.02 | 0.05 | 0.01 |
| Log likelihood | -516.35 | -617.64 | -274.53 | -370.95 |
| VOT (£/min) | 1.17 | NA ** | 0.55 | 0.77 |
| VOT (£/hr) | 70.00 | NA ** | 32.94 | 46.15 |
| Number of sample | 504 | 600 | 272 | 344 |

* The VOT is not calculated because the coefficient for the travel cost variable is not statistically significant at the 95% level of confidence.

In each model, only time and cost variables were included. These variables presented were significant at the 95% level of confidence apart from the travel cost parameter for cluster 2. Regarding the rho-square of the models, there were some improvements in the clustered data compared to the model for all respondents, even though the improved rho-square were still smaller than the good one as suggested by Hensher *et al.* (2005) and Louviere *et al.* (2000) which is between 0.2 and 0.4.

Table 10.4 clearly shows that VOT does vary among the clusters. The coefficient of the variable cost in the model of cluster 2 was not significantly different from zero suggesting that the cost variable was not influencing the utility. The model also suggested that many respondents were more dependent on travel time than cost when evaluating alternatives. Regardless of the cost, the utility was higher when travel time was shorter. As the parameter of the variable travel cost was not significantly different from zero, the VOT was not calculated.

The VOT on business was higher than for leisure. Frequently travelling males on business have a VOT of £1.17/min or 70/hour, which is the highest among all clusters which was similar to the VOT for 1st class passenger in Wardman (2004) and Tapley (2008). Infrequent female travellers on business valued time at £0.77/min or 46.15/hour which was similar to the VOT of standard class passengers travelling for business in Wardman (2004). However, the VOT of the infrequent elderly male travellers for leisure was £0.55/min or 32.94/hour which was higher than the VOT for leisure trip found by Wardman (2004). The VOT of a leisure trip is just about a half of the business trip.

As the NEB was dominant in all clusters except cluster 2, where the EB was dominant but the parameter of cost was not statistically significant at the 95% level of confidence so that the VOT cannot be derived, the effect of the main activity groups of respondents on the VOT cannot be compared based on the clustered data. Therefore, an analysis of data by the main activity groups was conducted and will be discussed in the next section.

### *10.3.3 Estimation of Multinomial Logit (MNL) models considering main activity groups*

Therefore, in order to specifically investigate the effect of the use of electronic devices on the VOT, DCA analyses were carried out for each group of data based on their declared main activity namely electronic based (EB), non-electronic based (NEB) and personal engagement (PE). Again taking into account only travel time and cost variables in the analysis, the statistical parameters for the MNL model for the data is shown in Table 10.5.

Table 10.5 The MNL models by main activity groups (tvalues are in bracket)

| **Attributes** | **Coefficients (EB)** | | **Coefficients (NEB)** | | **Coefficients (PE)** | |
|---|---|---|---|---|---|---|
| Cost | 0.001 | (0.154) | **-0.033** | **(-5.812)** | **-0.018** | **(-4.531)** |
| Time | **-0.017** | **(-4.644)** | **-0.028** | **(-8.860)** | **-0.019** | **(-9.472)** |
| $\rho^2$ | 0.01 | | 0.04 | | 0.02 | |
| Log likelihood | -580.50 | | -857.56 | | -1788.42 | |
| VOT (£/min) | NA * | | 0.85 | | 1.06 | |
| VOT (£/hr) | NA * | | 50.91 | | 63.33 | |
| Number of observations | 568 | | 840 | | 312 | |

* The VOT is not calculated because the coefficient for the travel cost variable is not statistically significant at the 95% level of confidence.

Table 10.5 shows that the variables are statistically significant at the 95% level of confidence, except the parameter of the variable cost for EB model. The rho-square of the models was not much improved compared to the models discussed in the previous section. The VOT for the NEB model was lower than for the PE, whilst the VOT for EB was not calculated due to the insignificance of the cost parameter. Compared to the findings of Tapley (2008) and Wardman (2004), the VOT found in this section were lower than that for the 1$^{st}$ class but higher than for the standard class passengers.

### *10.3.4 Discussion on the MNL model of the entire data set*

Three MNL models were investigated for a) the complete data b) segregated by cluster with different characteristics and c) main activity group. The VOT of the complete data set was found to be £1.06/min or 63.60/hour whilst for each cluster 1, 3 and 4 were changed to £1.17/min or 70.00/hour, £0.55/min or 32.94/hour, and £0.77/min 46.15/hour respectively. These results reflected the importance of clustering by demographic because the VOT differences reflected the higher values placed on time by business travel being higher for frequently travelling males to infrequent female travellers. Male passengers on an occasional leisure trip had the lowest VOT. The VOT for cluster 2 was not calculated because the parameter of the variable cost was not statistically significant at the 95% level of confidence. Similarly, the MNL model for the data segregated according to the main activity of responders whilst travelling found that the variable cost was not statistically significant at the 95% level of confidence for the EB group. On the other hand, all parameters for the NEB and PE were statistically significant at the 95% level of confidence. The estimated VOT for NEB was £0.85/min or 50.91/hour whilst for PE was £1.06/min 63.33/hour.

With recognition that the classification of the data in this study and previous study by Tapley (2008) and Wardman (2004), the VOTs' for some groups of respondents in the studies were similar such as those in the cluster 1 in this study have similar VOT with those who in the 1$^{st}$ class in the Tapley (2008) and Wardman (2004) studies. However, the rho-square of this study were considered smaller than 0.3 which was believed to produce more decent model fit (Hensher *et al*., 2005).

Furthermore, the variable cost was found to be statistically insignificant at the 95% level of confidence for cluster 2 and EB models reflecting that the inclusion of the non-trading responses in the analysis leads to a bias in the model as discussed in Hess *et al.* (2010). According to Hess *et al.* (2010), the non-trading in choice behaviour refers to the situation where a respondent always chooses the same options across the choice set, which may reflect the presence of extreme preference in the questionnaire, that responders have misunderstood the questions, the effect of boredom, or a strategic behaviour related to a controversial issues. As a solution, Hess *et al.* (2010) suggested including the non-trading responses when the behaviour results from the presence of the extreme preference. On the other hand, the non-trading data should be excluded when the non-trading results from boredom, misunderstanding or because of strategic issues. In practice, it is impossible to discriminate whether the non-trading is due to the presence of extreme preferences or because of other reasons. Therefore, in the next step of the analysis it is sensible to exclude the non-trading responses.

## 10. 4 Discrete Choice Analysis of Data Set Excluding Non-Trading

This section discusses DCA of the SP data set with the exclusion of the non-trading responses. As discussed in Section 10.3.4, the presence of the non-trading responses in the data set led to a bias in the model estimation, therefore, they were excluded from further analysis.

The number of non-traders found was 65 respondents or about one-third of total respondents who completed the SP questionnaires. The characteristics of them are presented in Table 10.6.

There was no indication that the non-traders belong to a specific group of respondents, as the proportions of them were similar to the proportions of the whole respondents shown in Table 6.2.

Consistent with previous analysis, MNL was carried out with respect to cost and travel time variables, firstly with the complete data set followed by the segregated data according to socio-demographic clusters and the main activity groups of responders. The results are summarised in Table 10.7-10.9.

Table 10.6 Characteristics of the non-trader respondents

| Attributes | | Male (%) | Female (%) | Total |
|---|---|---|---|---|
| **Main Activity Group** | | | | |
| - | EB | 16.9 | 10.8 | 27.7 |
| - | NEB | 24.6 | 23.1 | 47.7 |
| - | PE | 12.3 | 12.3 | 24.6 |
| | **Total** | **53.8** | **46.2** | **100.0** |
| **Journey Purpose** | | | | |
| - | Employer's business | 24.6 | 20.0 | 44.6 |
| - | Commuting to/from work | 4.6 | 0.0 | 4.6 |
| - | Personal business | 4.6 | 6.2 | 10.8 |
| - | Visiting friends/relatives | 9.2 | 6.2 | 15.4 |
| - | Holiday/short break | 1.6 | 6.2 | 7.8 |
| - | Leisure | 4.6 | 3.0 | 7.6 |
| - | Other | 4.6 | 4.6 | 9.2 |
| | **Total** | **53.8** | **46.2** | **100** |
| **Employment Status** | | | | |
| - | Employed | 40.0 | 29.2 | 69.2 |
| - | Self-employed | 7.6 | 4.6 | 12.2 |
| - | Retired | 3.1 | 4.6 | 7.7 |
| - | In full time education | 3.1 | 6.2 | 9.3 |
| - | Looking after home | 0.0 | 1.6 | 1.6 |
| | **Total** | **53.8** | **46.2** | **100.0** |
| **Age** | | | | |
| - | 18-24 | 6.2 | 7.6 | 13.8 |
| - | 25-34 | 9.2 | 6.2 | 15.4 |
| - | 35-44 | 9.2 | 10.8 | 20.0 |
| - | 45-54 | 13.8 | 9.3 | 23.1 |
| - | 55-64 | 13.8 | 7.7 | 21.5 |
| - | 65 or more | 0.0 | 3.1 | 3.1 |
| - | Prefer not to say | 1.6 | 1.5 | 3.1 |
| | **Total** | **53.8** | **46.2** | **100** |

Table 10.7. The MNL models for data altogether, excluding the non-trading

| Attributes | Coefficients (altogether data) | t-value |
|---|---|---|
| Cost | **-0.036** | -7.162 |
| Time | **-0.024** | -9.798 |
| $\rho^2$ | 0.04 | |
| Log likelihood | -1219.06 | |
| VOT (£/min) | 0.66 | |
| VOT (£/hr) | 40.00 | |
| Number of observations | 1160 | |

Table 10.8. The MNL models for clustered data, excluding the non-trading (t-values are in bracket)

| Attributes | Coefficients (Cluster 1) | Coefficients (Cluster 2) | Coefficients (Cluster 3) | Coefficients (Cluster 4) |
|---|---|---|---|---|
| Cost | **-0.036 (-4.088)** | **-0.033 (-3.931)** | **-0.062 (-3.831)** | **-0.042 (-3.399)** |
| Time | **-0.035 (-6.397)** | **-0.018 (-5.033)** | **-0.032 (-4.935)** | **-0.025 (-3.624)** |
| $\rho^2$ | 0.06 | 0.002 | 0.06 | 0.03 |
| Log likelihood | -323.59 | -442.981 | -196.32 | -247.51 |
| vOT (£/min) | 1.03 | 0.55 | 0.52 | 0.60 |
| VOT (£/hr) | 58.33 | 32.73 | 31.20 | 35.71 |
| Number of observations | 320 | 416 | 192 | 232 |

Table 10.9. The MNL models for group based on main activity, excluding the non-trading (t-values are in bracket)

| Attributes | Coefficients (EB) | Coefficients (NEB) | Coefficients (PE) |
|---|---|---|---|
| Cost | **-0.019 (-2.214)** | **-0.052 (-6.925)** | **-0.030 (-2.471)** |
| Time | **-0.022 (-5.235)** | **-0.031 (-8.234)** | **-0.012 (-2.214)** |
| $\rho^2$ | 0.01 | 0.06 | 0.01 |
| Log likelihood | -429.20 | -590.92 | -189.91 |
| VOT (£/min) | 1.16 | 0.60 | 0.40 |
| VOT (£/hr) | 69.47 | 35.77 | 24.00 |
| Number of observations | 408 | 576 | 176 |

It was noticeable that the removal of the non-trading responses improved the model estimates in Table 10.7 to 10.9 compared to those in Section 10.3. All of the coefficients of the models were statistically significant at the 95% level of confidence. As expected, the estimated VOTs reduced when the non-trading was excluded from the analysis compared to when they were included. However, the rho-squares' were not significantly improved compared to those in the previous sections. This may be due to the model fit included only two attribute parameters without intercept as they were 'unlabelled' choice models.

The analyses of VOT for clustered data found that the VOT for a business trip was higher than for leisure. Conversely, the analysis for the segregated data according to the main activity group found that the EB has the highest VOT, followed by the NEB and PE respectively. However, the estimated VOT of cluster 2 was found to be the lowest among other clusters despite the purpose of the journey being mainly for business.

Arguably the lower VOT for those in cluster 2 was because the responders were mainly young employees and students who prefer to save money rather than reach their destination earlier.

This study found that, overall the estimated VOT was £0.66/min or 40.00/hour. The minimum VOT found in this study was £0.40/min or 24.00/hour for those who engaged in PE activities and the maximum was £1.16/min or £69.47/hour for those choosing EB activities. However, these results were obtained from data without stratifying the first and the standard passenger cohorts. It is more sensible to differentiate between the first and the standard class passengers in the analysis because travel costs for the first class is relatively higher than for standard class. Therefore, further analyses were carried out with the segregated data according to the ticket class. The results will be discussed in the Section 10.5.

## 10. 5 Discrete Choice Analysis for Data Segregated by Ticket Type

At the time of this study, there were two different types of ticket available on East Coast Mainline trains namely for first and the standard class travel. The ticket types reflect different quality of services offered in separate coaches. In the first class coaches, passengers receive complimentary food and drink, waiting lounges at stations, larger and more comfortable reclining seats each with its own table, complimentary Wi-Fi, and computer or mobile phone plug sockets. However, in the standard class coaches, passengers have less comfortable seats, electric plug sockets, and small tables attached to the rear of the seat in front. In addition, several tables are shared by four passengers, a refreshment bar or trolley service and Wi-Fi at an additional cost. Given the higher cost for the first compared to the standard class, further VOT analysis using DCA was carried out on the data sets, which were separated according to ticket type.

As before, cost and time were considered as generic variables and the results are presented in Table 10.10 to 10.12. The model for the total data was presented first, followed by the data segregated according to the socio-demographic clusters and the main activity group. Due to the small amount of data available for first class passengers, the analysis for this class was carried out for all the data only. All of the variable parameters in the models were statistically significant at the 95% level of confidence. However, the rho-squares were still below the suggestion of Louviere *et al.* (2000).

Table 10.10. The MNL models for the first and standard class (t-values are in bracket)

| **Variable** | **Coefficients (First Class)** | **Coefficients (Standard Class)** |
|---|---|---|
| Cost | **-0.035 (-2.711)** | **-0.029 (-4.859)** |
| Time | **-0.041 (-5.848)** | **-0.019 (-6.576)** |
| $\rho^2$ | 0.09 | 0.03 |
| Log likelihood | -198.77 | -819.70 |
| VOT (£/min) | 1.17 | 0.66 |
| VOT (£/hr) | 70.29 | 39.31 |
| Number of observations | 208 | 744 |

Table 10.11. The MNL models for the standard class by clusters (t-values are in bracket)

| **Attributes** | **Coefficients (Cluster 1)** | **Coefficients (Cluster 2)** | **Coefficients (Cluster 3)** | **Coefficients (Cluster 4)** |
|---|---|---|---|---|
| Cost | **-0.024 (-2.000)** | **-0.032 (-3.238)** | **-0.033 (-1.996)** | **-0.041(-2.845)** |
| Time | **-0.031 (-4.510)** | **-0.015 (-3.733)** | **-0.014 (-1.754)** | **-0.019(-2.502)** |
| $\rho^2$ | 0.05 | 0.003 | -0.03 | 0.02 |
| Log likelihood | -204.18 | -308.50 | -112.09 | -180.21 |
| VOT (£/min) | 1.29 | 0.47 | 0.42 | 0.46 |
| VOT (£/hr) | 77.50 | 28.13 | 25.45 | 27.80 |
| Number of observations | 192 | 280 | 104 | 168 |

Table 10.12. The MNL models for the standard class data grouped by main activity.

| **Attributes** | **Coefficients (EB)** | **Coefficients (NEB)** | **Coefficients (PE)** |
|---|---|---|---|
| Cost | -0.012 (-1.106) | **-0.039 (-4.515)** | **-0.042 (-2.632)** |
| Time | **-0.013 (-2.362)** | **-0.026 (-6.108)** | **-0.009 (-1.439)** |
| $\rho^2$ | 0.004 | 0.05 | -0.01 |
| Log likelihood | -285.34 | -427.57 | -110.21 |
| VOT (£/min) | NA * | 0.67 | 0.21 |
| VOT (£/hr) | NA * | 40.00 | 12.86 |
| Number of observations | 248 | 392 | 104 |

* The VOT is not calculated because the coefficient for the travel cost variable is not statistically significant at the 95% level of confidence.

Table 10.10 to 10.12 demonstrates that the VOT for the first class passengers is twice the standard class passengers. However, when the data were clustered by socio-demographic, the VOT of cluster 1 (mature males on business) in the standard class is higher than the VOT of the first class passengers. This may be because of the spread in the responses of the whole sample is removed by the clustering process. Also it follows that the mature male business passengers, due to their employment status, would work in challenging the cutting edge environment and is less likely to book tickets in advance having to respond to day to day business demands requiring last minute travel plans. Purchasing a ticket, which is more costly than the advance or off-peak first class ticket at the station before departure is commonplace in business and commerce. At the time of this study, the ticket price policy in the UK offered different ticket prices depending on the time of purchase. The ticket prices were more expensive if booked on the day of departure rather than bought in advance or for off-peak travel.

The VOT for the first class passengers found in this study was £1.17/min or £70.29/hour and this is slightly lower than the finding of Wardman (2004) and Tapley (2008) (£1.19/min or £71.13/hour and £1.22/min or £73.22/hour at the quarter 3 2011 price respectively). On the other hand, the £0.66/min or £39.31/hour of VOT for standard class passengers found in this study, was slightly lower than £0.72/min or £43.79/hour found in Wardman (2004) and was higher than £0.48/min or £28.47/hour found in Tapley (2008). In this comparison, it is important to note that the VOT in this study was for all purposes whilst Wardman (2004) and Tapley (2008) were for business purpose only. The comparison of these studies in the same classification of respondents was not conducted because lack of data.

When the data were segregated by main activity, the parameter of cost for the EB was not statistically significant at the 95% level of confidence and therefore was not calculated. The VOT of the NEB was higher than the PE (£0.67/min or 40.00/hour compared to £0.21/min or 12.86/hour respectively). The VOT for PE group in this study was similar to for commuting and leisure trips in Wardman (2004) whilst for the NEB group was similar to for business trip in standard class found in Wardman (2004).

## 10. 6 The Effect of the Perception of Time and Technology on the VOT

In this section, the VOT will be compared between the clusters and the main activity group with respect to the perception of time resulted from Chapter 7 and 8. As discussed in Chapter 7, for EB, NEB and PE, the perceived travel time was higher, lower and equal to the actual respectively. However, Chapter 8 showed that respondents in cluster 1 and 4 perceived travel time lower than the actual, whilst cluster 3 and 4 equal to the actual. In this chapter, the VOT for those in cluster 1 and 4 were higher than those in cluster 2 and 3. The results are summarised in Table 10.13 and 10.14. In general the analyses suggest that those who perceived travel time to be higher than actual have a higher VOT.

Table 10.13. Summary of the estimated VOT by clusters

| Data | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| Perceived travel time (compare to the actual) | Higher | Equal | Equal | Higher |
| VOT of entire data (£/hr):<br>- Included non-trader<br>- Excluded non-trader | <br>70.00<br>58.33 | <br>NA*<br>32.73 | <br>32.94<br>31.20 | <br>46.15<br>35.71 |
| VOT of standard class excluded non-trader (£/hr) | 77.50 | 28.13 | 25.45 | 27.80 |
| VOT of first class excluded non-trader (£/hr) | 70.29 | | | |

* The VOT is not calculated because the coefficient for the travel cost variable is not statistically significant at the 95% level of confidence.

Table 10.8b. Summary of the estimated VOT by main activity group

| Data | EB | NEB | PE |
|---|---|---|---|
| Perceived travel time (compare to the actual) | Higher | Lower (with 13 minutes penalty) | Equal |
| VOT of entire data (£/hr):<br>- Included non-trader<br>- Excluded non-trader | <br>NA*<br>69.47 | <br>50.91<br>35.77 | <br>63.33<br>24.00 |
| VOT of standard class excluded non-trader (£/hr) | NA* | 32.31 | 12.86 |

* The VOT is not calculated because the coefficient for the travel cost variable is not statistically significant at the 95% level of confidence.

Table 10.8a and Table 10.8b show that the VOT is higher when the perceived travel time is higher for the clustered data, however, when the data were segregated by the main activity mixed messages emerged. The VOT for the EB was not calculated because of the cost variable was statistically insignificant at the 95% level of confidence for the the non-trader, as well as for the standard class model when the non-trader were excluded.

### 10. 7 Summary

Discrete choice analyses have been carried out and discussed in this chapter focused on the comparison of the estimated VOT of respondents from different groups and different activities whilst travelling. The data set was based on an unlabelled-choice experiment by considering the cost and travel time as variables. The initial analysis was conducted on the data as a whole followed by the data segregated by clusters and by main activity group. Given that *unsatisfied* results were found in the first model which included non-trading responses, further analyses were carried out in which the non-trading responses were excluded. The exclusion of the non-trading responses improved the statistical significance of the model where all of the variables in all models were statistically significant and the VOT estimated from the model reduced.

The study found that the VOTs of cluster 1, 2 and 4 (mainly for business) were higher than cluster 3 (mainly for leisure). It is difficult to conclude that those who engaged in the EB activities had a higher VOT than others, as the cost parameter of two of the three models for the EB were not statistically significant at the 95% level of confidence. However, given the main activity of cluster 2 was EB, a higher VOT is expected due to them being productive travellers. Given that the VOT estimated in this study was based on limited sample and did not cover all segments of rail passengers in the UK, these estimates of the VOT for rail passengers should be used with caution if used for other rail travel in the UK.

As the rho-square of the models were very small compare to other studies as discussed in Louviere *et al.* (2000) and Hensher *et al.* (2005), the use of more advance models such as mixed logit model or latent class model might produce a more decent model fit.

# Chapter 11: Conclusions

In this chapter, a summary of the research carried out is presented. A number of conclusions are drawn and future research is documented.

The effect of technologies on the perception and value of travel time has been discussed in many studies (Ettema and Verschuren, 2007; Lyons and Urry, 2005; Lyons *et al.,* 2007; Lyons *et al.*, 2012; Wardman, 2001; Mokhtarian *et al.*, 2001). The general concerns were that the use of technology was expected to decrease the perception of time and in-turn decrease the value of travel time. Despite some studies attempting to clarify this hypothesis, the need for further research in particular to develop a more reliable method and more statistically sound evidence to support findings, was evidenced (Lyons *et al.*, 2012). Therefore, the research presented in this thesis aimed to investigate how the use of technology represented such as personal electronic devices, whilst travelling by train influenced attitudes, perceptions and value of travel time. It is argued that this knowledge could play a pivotal role in train service policy and practice in the future because the trend in the use of mobile technologies was predicted to increase over time.

The aim of this research was directed by the three main findings of previous studies; 1) a face to face interview conducted in the 1980's found that travel time was perceived as being 8% higher than the actual (Wilson, 1983) but by 2007 a self-completion questionnaire before or after the journey discovered that travel time was considered to pass more quickly (Lyons et al, 2007); 2) there was evidence to suggest that the value of time decreases over time (Wardman, 2001) and; 3) there were some indications that the activity conducted whilst travelling influences the VOT, for example those who were listening to music whilst travelling were found to have the lowest value of time (Ettema and Verschuren, 2007).

In this study, perceptions, attitudes, and behaviour of respondents during the journey were recorded through face-to-face interviews using a bespoke SP questionnaire on the East Coast Mainline trains travelling between Newcastle and London. The main activities of respondents were grouped into three types namely electronic based (EB), non-electronic based (NEB) and personal engagement activity (PE) based on the completed questionnaire. However, cluster analysis was conducted to assign respondents into groups based on their journey, and demographic characteristics data, whilst factor analysis was conducted to reduce the number of descriptors by identifying interrelated variables. Relationships between the perceived and actual travel time for different groups of travellers were investigated using linear regression analysis. Discrete choice analysis was conducted to model the trade-off between travel time and cost made by respondents and to estimate their VOT.

There was statistical evidence at the 95% level of confidence found in this study to suggest that the use of technology does influence the perception of time and in turn governs the value of travel time. However, contrary to expectation, those who mainly engage in EB activity emerged as having the highest perception of time, whilst those who engaged in NEB have the lowest with PE in between. Cluster analysis confirmed that the mainly NEB group has the lowest perception of travel time compare to EB and PE.

There is evidence that the use of technology has a significant effect on shaping the attitude of travellers in relation to train services. Compared to NEB and PE, those who engaged in EB were more receptive to technology because the availability of free Wi-Fi on-board was perceived to decrease fatigue when the journeys suffered delay. In response to the question specifically asking opinions about small increases in journey time and cost if free Wi-Fi is available on-board, those who engaged in EB activity were found to be more likely to accept the additional travel time than other groups, however, all groups were found to be less likely to accept the additional cost.

There was evidence that the use of technology affects the VOT. Those who engaged in the EB activity have a higher VOT than either NEB or PE. However, some inconsistencies in the results emerged from the two-step cluster analysis which revealed that age, gender and trip purpose were drivers for the VOT. The clustered group that consisted mainly of mature males on business emerged with the highest VOT of £58.33/hour, whilst the mainly mature females on business had the second highest of £35.71/hour. The mainly young employed and elderly males on leisure trip groups emerged to have the lowest VOT of £32.73/hour and £31.20/hour respectively.

The perceived travel time was found to have little influence on the VOT as those who perceived travel time higher than actual did not always have a higher VOT. For example, the EB group with the highest perception of travel time emerged as also having the highest VOT whilst in the clustered data, the mainly young travellers on business and elderly males for leisure with higher perception of travel time (compared to the mature males and females on business) had a lower VOT.

## 11. 1 Main Findings

The following main findings can be drawn from the research carried out:

1. Similar to the previous studies such as Lions *et al.* 2013, this study provided the evident of high proportion of traveller use their travel time productively. Reading a printed book/magazine was found to be the main activity of most of respondents. However, this study also found that a great proportion of respondents were mainly engaging in electronic based activities whilst travelling.
2. To some extend, the use of technology was found to influence the perception of time. Those who engage in electronic devices whilst travelling perceived travel time higher than the actual travel time, which may be due to the productivity achieved when using the electronic devices whilst travelling.
3. There were some correlations between the use of technology whilst travelling and the attitudes/opinions of travellers towards the train services. The perception of time for those who engaged in electronic based activity has a correlation with the attitude towards train services when Wi-Fi available for free on-board. On the other hand, the perception of time for those who engaged in non-electronic based and personal engagement activity have a correlation with train comfort and productivity respectively.
4. The use of technology whilst travelling was found to influence the value of time of the travellers. Those who engaged in electronic based activity was found to have higher VOT compare to other group of respondents.

## 11.2 Secondary Finding

Along with the main findings above, this study also provides more evidence and secondary findings as follows:

1. From the literature review the need for further research to deliver more evidence of the influence of the use of technology whilst travelling on the perception and value of travel time was highlighted thus confirming the originality of the research delivered in this thesis.

2. A sound research methodology using face-to-face interviews was conducted to obtain the perceived travel time in real-time during the actual travel experience and thus, presented the opportunity to explore the effect of passengers' activities on their perceptions, attitudes, opinions, feelings, and value of travel time.
3. Face-to-face interviews consistent with Wilson (1983) and Mishalani *et al.* (2006) were found to have an advantage over other methods documented in literature, as they allowed the psychological aspect such as the emotional feelings of the respondents toward the journey to be reflected in the answer of the given questions.
4. Given the wide range of differences in the ticket prices a practical method to quantify the cost options in the SP in a consistent way using the percentage change in the value was demonstrated to have advantages over the use of a fixed absolute value for all respondents. This proved successful because it provided the same proportion of change to all respondents, avoided offering unreasonable values, and produced a wide range of different combination of levels for the attribute values.
5. Overall, the perceived travel time was not statistically significantly different from the actual. However, differences in perception of time emerged in the disaggregated data. Based on the main activity, the EB group was found to have perceived travel time as higher than the actual, whilst the NEB group perceived travel time lower than actual. The PE group perceived travel time equal to the actual.
6. The perception of travel time of the EB group was attributed to the amount of work achieved during the journey rather than the enjoyment of the activity on the trip, as pointed in a previous study (Ettema and Verschuren, 2007).
7. Some inconsistencies in the results emerged from the two-step cluster analysis, which revealed that the main activity was less likely to influence the perceived travel time. Instead age, gender and employment status of respondents were statistically significant drivers in the perception of travel time. Mature business travellers perceived travel time as lower than the actual whilst for younger and older travellers there was no statistically significant difference. Mature males on business perceived travel time to be lower than mature females on business, whilst younger and older passengers perceived travel time to be higher than mature business travellers (both male and female).

8. More than half of respondents reported that they had the opportunity to work during the journey and one-fifth considered working on the train was more productive than in the office, however, one-third of respondents reported that it was less productive.
9. The EB group was 70% more likely to agree with the statement that journey time was perceived to pass more quickly when using personal electronic devices. This finding was in inconsistent with the estimation of the passage of time, which suggested that time was 10% slower. A possible explanation for this is that the estimation of the passage of time was influenced by the amount of work achieved, therefore, the responses to the question was irrespective of the use of any electronic devices.
10. The EB group was found to be more likely to accept the delay and additional increment in travel time when free Wi-Fi is available on board. This is consistent with the interpretation proposed in 9 above. However, the free access to the Wi-Fi may not be able to encourage respondents to prepare for any additional cost.
11. The train journey on the East Coast Mainline between Newcastle and London was perceived to be comfortable and respondents expressed that they would encourage more people to use train services.
12. The perception of travel time was found to have a positive correlation with the factor of technology suggesting that the use of technology increases the perception of travel time. Arguably the increase in the perception of time when using the technology was consistent with the above attributed to the amount of work achieved during the journey rather than disutility of the travel time.
13. The journey comfort whilst travelling in the train was negatively correlated to the perception of travel time. The more comfortable the train the lower the perception of travel time and the more likely the journey to pass quicker.
14. The main activity and the perception of travel time were found to be less likely to drive the VOT because some inconsistencies were found in the results. When the data was segregated by the main activity group, the EB group was found to have a higher perception of travel time as well as VOT than other groups. However, the clustered data showed that the mainly young employed in a business group had a higher perception of travel time compared to other clusters, but their VOT was the lowest.

15. This result revealed that trip purpose and demographics were more likely to play a role in influencing the VOT which was endorsed by the results of the two-step cluster analysis which showed that the mainly young and elderly cluster perceived travel time to be equal to the actual and had the lowest VOT. The mainly mature female on business group emerged as having the lowest perception of time and second highest VOT, whilst the mainly mature male in the business cluster had the highest VOT and the second highest perception.
16. An inconsistency was found when assessing the influence of the frequency of using train services on the perception of travel time. Both frequently travelled mature males and infrequently mature females on business perceived travel time lower than the actual, whilst frequently travelled younger passengers on business and infrequently travelled elderly males for leisure perceived travel time as equal to the actual.

## 11.3 Policy Implications of the Study

Similar to others, this study was expected to have a recommendation for a better policy in the future. However, to apply the recommendation given in this section into practice, a careful consideration should be taken as the study has its limitation as discussed in section 11.4.

A large proportion of respondents reported that they were accessing Internet whilst travelling either using Wi-Fi or a cellular network. This is a potential market for the train company to encourage people to travel by train and increase their patronage by providing a more reliable access to Internet on-board. However, the ISA analysis suggested that the Wi-Fi service on-board was less important in the perception of the respondents and most of them could not decide whether they were satisfied or not with the service. This may be because they did not use the service as they have already obtained Internet access through their mobile providers or they expect a more reliable access from the Wi-Fi service on-board. This finding challenges train companies to improve their Wi-Fi service to be more reliable in term of speed/bandwidth over common cellular networks (3G or 4G) and to decrease the additional charge for using the service.

Other aspect that needs more attention from the train operators is the ticket price as it is very important to travellers and they expect it to be reduced. There was some evidence to suggest that travellers expect to obtain a less expensive ticket price to encourage them to use more train services (Passenger Focus, 2009). Similarly, this study found that a small increment in cost is less acceptable compared to the possibility to have a delay or increment of travel time when the Wi-Fi service available on-board especially for those who engaged in EB activities whilst travelling. Lyons *et al.* (2013) found that the proportion of travellers who engaged in electronic based activities and use their travel time more productively has significantly increased compared to the findings of previous study (see Lyons *et al.* (2007)). The use of technology was predicted to increase over time as technology consistently advanced and the price become more affordable. More over, the new generation who was born and grown up in the digital era will be attached to a wireless device. Lasica (2007) named this generation as "The Mobile Generation." This generation will be more rely on electronic devices and Internet access whilst travelling, therefore challenges train operators to accommodate their need such as providing enough space to work, power socket, and a high speed Internet access.

A positive relationship between the perceived and the value of travel time was found in this study where those who perceived travel time higher than actual have higher VOT compared to others. However, a more insight investigation using cluster analysis revealed that the perception of time did not consistently indicate whether the VOT is higher or lower. Age, gender, and journey purpose were found to be the most influential attributes of the VOT where mature male on business has the highest one and elderly male on leisure trip and young people on business has the lowest one. Therefore, when the concept of generalised cost is used in estimating the cost and benefit ratio of an infestation on train services, target segmentation of the train based on their age, gender and journey purpose has to be considered. Reduction of travel time is important when the VOT of the target segmentation is high such as business travellers, regardless whether they use travel time productively or not, because they would pay more to reduce the travel time.

## 12 Limitation of the Study

The research reported here has drawn upon data collected from a stated preference survey conducted on-board of trains travelling between Newcastle and London. Caution must be taken when applying these results in practice. It should be remembered that the study was conducted on board an East Coast Mainline train travelling from Newcastle to London in the morning and from London to Newcastle later in the day. The characteristics of the train service and passengers are likely to be different on the other train services operated by other rail companies at other times in the day.

The issues considered of importance in this study for example may be unimportant on another service or vice versa, issues not highlighted here may be of importance in another study. Therefore the scope exists for adapting the questionnaire and analysis procedure and repeating the research on other rail services offered by companies at various times and on a wider spectrum of routes. Caution should also be taken given the under representation of commuters and first class passengers in this study. Therefore, studies specifically targeting routes to study the perception of travel time of commuters given that they form the largest proportion of train users in the UK would be of value and complementary to the research presented in this thesis. A similar study of first class business travellers, who may gain more benefit from the advancement of technology for productive use of travel time due to free access to Wi-Fi, would be interesting.

Even though the study found that those who engaged in EB perceived travel time higher than actual, it is not necessarily inconsistent with the finding that travel time seems to pass more quickly. There was a possibility that this group of people have a very high perception of time, however given access to electronic devices opening the potential to use travel time more productively, their perceived time has been reduced but to a level of 10% higher than the actual.

Another limitation of this study was that the interviewer did not directly observe the respondent's activities reported and no guarantee that the responder had not checked the time on a wrist watch or mobile service prior to interview. This would lead to misrepresented data contributing to the relationship between the perceived and actual travel time leading to bias towards a slope equal to unity and reduced regression coefficient because their estimation of the passage of time would be more accurate.

Difficulties have arisen when attempting to compare the perception of time found in this study with previous studies, mainly because the focus and methodological approach are different. Similar research by Wilson (1983) in 1980's was of passengers travelling on a local train, whilst this study was interested in the intercity train travellers. The comparison between the perceived and actual travel time was more difficult for more recent studies because they were conducted using qualitative approaches, and therefore, have not derived the linear relationship used in this study.

## 11.5 Future Research

Whilst this research has successfully contributed new knowledge, as with all research there remains opportunity for further research and potential areas include a modification of the methods in data collections and analysis to obtain more robust results.

Direct observation of passenger activities whilst travelling and measurement of the proportion of time allocated to each activity would have increased the confidence in the perception of time information. This should be achieved with the use of a camera recorder or a direct observation technique. However, this would require agreement from the passengers to overcome ethical issues. A combination of the direct observation and face-to-face interview would provide a useful comparative assessment of the proportion of travel time used for each activity; however, this would require more surveyors and as a result, increased costs. Furthermore, an estimation of the productivity of respondents provided would have enhanced the understanding of the interaction between productivity, perception of time and the VOT.

In respect to the multi-tasking ability where travellers can engage in more than one activity at the same time or conduct several activities simultaneously such as listening to music whilst reading a book and chewing a gum, makes the relationship between the activity whilst travelling and the perception of time probably has been influenced by the secondary activities as well as the main activity. For example, a traveller who reported their main activity was reading a book might also enjoying the music at the same time and their perception of time might be influenced by both, the book they read and the music they listened. Therefore, in the future research, it might be useful to include not only main activity but also secondary activities of respondents in the analysis.

The existence of the extremes in the data could not be identified as outliers i.e. bad data and the expectation was that they would emerge as a group in the cluster analysis. This was not the case, therefore, rather than considered as outliers, the data in fact may belong to a specific group of travellers that have been too few in samples to emerge as a group, or they resulted from an unusual event or circumstances out of the scope of this study. In the former case, a caution should be taken in omitting the observation because rejecting an observation may be throwing away vital information which could lead to the discovery of a hitherto unrecognised factor as pointed out in Kennedy and Neville (1964). Therefore, future studies should aim to carry out more interviews. On the other hand, the latter case it is arguable that the data should be removed prior to the analysis because they were unlikely to be representative of the specific population being studied and may have introduced bias in the results. However, to distinguish between the two cases, further studies would require additional questions to reveal the underlying causes of this "*abnormal*" data.

The rho-square of the MNL model in this study was very small to be considered as a decent model fit. The highest rho-square found in this study was 0.09 compared to the good model fit rho-square of 2.0-4.0 as discussed in some references such as Hensher *et al.* (2005) and Louviere *et al.* (2000). Therefore, it is recommended to consider a more advanced model such as mixed logit model or latent class model for further analysis of the data to obtain a better model fit.

A part of this study, it might be useful to conduct further investigation on the effect of the possibility to conduct a more productive and enjoyable activities whilst travelling using the advanced technology on the perception of level of service and the willingness to book the train ticket. The train operators and regulators might gain valuable information from the study on whether to invest more money to provide more facility to encourage the positive use of technology whilst travelling or to invest in other services.

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# Appendix 1: Questionnaire Form

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Dear Traveller,

Thank you for taking the time to complete this short questionnaire today. This survey is being undertaken by a PhD student at the Transport Operations Research Group at Newcastle University. The information you provide will be treated in strictest confidence and will only be used for research purposes.

**STATEMENT OF CONSENT**

*(Please tick the box for each statement below)*

| | |
|---|---|
| 1. I agree to take part in the above study. | ☐ |
| 2. I understand that my participation is voluntary. | ☐ |
| 3. I understand I am free to withdraw at anytime without giving any reason, without legal rights being affected. | ☐ |
| 4. I am eighteen years of age or above. | ☐ |

***About the journey***

**Q1. At what station did you start your journey?**

______________________________

**Q2. What is your final destination station?**

______________________________

**Q3. According to the schedule, about how long will your journey take from the starting station to the final station (including interchange time if applicable)?**

______________________________

**Q4. Please estimate the price of a one-way ticket for your journey today?**

£ ______________________________

*To be completed by surveyor:*
*Date:* ____________ *Surveyor:* ____________ *Wifi available on train?: Yes/No**
*Time:* ____________ *(actual time when getting response for Q1) Interviewee Code:* ____________

**Q5. At which station did you board this train? (if different with Q1).**

______________________________

**Q6. At which station will you get off this train? (if different with Q2).**

______________________________

**Q7. Without looking at your watch please estimate (in minutes) how long you think you have been travelling on this train?**

______________________________

**Q8. How many train changes will you have to make before you reach your final destination?**

______________________________

**Q9. Please tick below all of the activities in which you have engaged on this train.**

| Activity | |
|---|---|
| **Advance Technology Based Activities** | |
| 1. Working on Computer | |
| 2. Reading/writing e-mails | |
| 3. Logging onto the Internet for work related purposes | |
| 4. Browsing Internet for leisure | |
| 5. Accessing social network website | |
| 6. Text messaging/making phone calls | |
| 7. Listening to radio/music | |
| 8. Watching a film/video | |
| 9. Playing digital games | |
| 10. Reading e-book | |
| **Non Advance Technology Based Activities** | |
| 11. Pen and paper work | |
| 12. Studying | |
| 13. Reading a printed book/magazine/ newspaper for leisure | |
| 14. Playing non-digital games | |
| 15. Chatting with other passengers | |
| 16. Eating and/or drinking | |
| 17. Entertaining children | |
| **Other Activities** | |
| 18. Enjoying the view | |
| 19. Thinking | |
| 20. Sleeping | |
| 21. Being bored or anxious | |
| 22. Other ____________ | |

**Q10. Which one of these activities did you do for the longest time? (Please write the corresponding activity number below)**

______________________________

**Q11. If you had not been using your portable electronic/digital device, in which activity would you have engaged in most?**

______________________________

**Q12. What electronic equipment have you used whilst travelling on this train? (Tick all that apply)**

- ☐1 Laptop/Netbook/Tablet (ex. iPad)
- ☐2 Smartphone (ex. iPhone, Blackberry)
- ☐3 Non internet Mobilephone
- ☐4 Multimedia Player (ex. iPod, MP4 Player)
- ☐5 Audio Player (ex. Audio CD Player, Radio)
- ☐6 Video Game (ex. Nintendo, Gamewatch)
- ☐7 E-book reader
- ☐8 Other____________________
- ☐9 None

**Q13. Which one of the above did you use most? (Please write the corresponding number)**

______________________________

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**Q14. Please estimate the proportion of your travel time on this train spent on technology based activities? (items 1-10 in Q9)**

______________________________

**Q15. How did you connect to the Internet? (Please tick all that apply)**

☐ 1 Not connected to Internet
☐ 2 *Wi-Fi* and Laptop/Netbook/Tablet (ex. iPad)
☐ 3 *Wi-Fi* and Smartphone (ex. iPhone, Blackberry)
☐ 4 3G and Tablet PC
☐ 5 3G and Smartphone
☐ 6 Broadband Dongle and Laptop/Tablet PC
☐ 7 Other (Please specify)

______________________________

**Q16. In total, how much would you be willing to pay to use the *Wi-Fi* provided on-board this train?**

______________________________

***About your ticket***

**Q17. What type of ticket do you have?**

| Class | Type | Single/Return |
|---|---|---|
| ☐ 1 First | ☐ 1 Anytime | ☐ 1 Single |
| ☐ 2 Standard | ☐ 2 Advance | ☐ 2 Return |
| | ☐ 3 Off-Peak | ☐ 3 Specific train |

**Q18. What type of Railcard do you use?**

☐ 1 None
☐ 2 16-25 yrs old or Full time student Railcard
☐ 3 Family and Friends Railcard
☐ 4 Senior Railcard
☐ 5 Network Railcard
☐ 6 Disabled Railcard
☐ 7 Other (please specify)

______________________________

**Q19. Please indicate who is responsible for paying the cost of the ticket?**

☐ 1 Myself
☐ 2 My employer
☐ 3 Someone else
☐ 4 Other (please specify)

______________________________

***If you booked the ticket yourself, please continue to Q20. Otherwise please go to Q22.***

**Q20. How did you book your ticket for this train?**

☐ 1 Pre-booked on-line and collected at station
☐ 2 Pre-booked by phone and collected at station
☐ 3 Pre-booked on-line and printed at home
☐ 4 Purchased ticket on departure
☐ 5 Purchased advance ticket at the station
☐ 6 Pre-booked on-line and delivered by post
☐ 7 Pre-booked by phone and delivered by post
☐ 8 Other (please specify)

______________________________

**Q21. When did you book your ticket for this train?**

☐ 1 Last minute before departure
☐ 2 Within the last day or so
☐ 3 Within the last week
☐ 4 Within the last fortnight
☐ 5 Within the last month
☐ 6 More than a month ago.

**Q22. What is the most important reason for choosing this train today?**

☐ 1 Price
☐ 2 Departure time
☐ 3 Arrival time
☐ 4 Convenience
☐ 5 Reliability
☐ 6 Number of changes
☐ 7 Guaranteed seat
☐ 8 Guaranteed table
☐ 9 *Wi-Fi* available
☐ 10 Other (please specify)

______________________________

**Q23. How many people are travelling with you at the moment in your party?**

______________________________

**Q24. How many return trips have you made by train in the UK (including this trip) during the last 4 weeks?**

______________________________

**Q25. What is the main purpose of your journey today?**

☐ 1 Employer's business
☐ 2 Commuting to/from work
☐ 3 Shopping
☐ 4 Personal business
☐ 5 Visiting friends/relatives
☐ 6 Holiday/short break
☐ 7 Leisure
☐ 8 Other (please specify) ______________

**Q26. In terms of travelling by train, how important to you are the following?**

Scale of 7=very important to 1=very unimportant

| Statements | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| **Availability of real-time information (on-line and at stations)** | | | | | | | |
| **Availability of *Wi-Fi* on trains** | | | | | | | |
| **Availability of *Wi-Fi* at stations** | | | | | | | |
| **Frequency of train services** | | | | | | | |
| **Able to guarantee a seat** | | | | | | | |
| **Electric power sockets** | | | | | | | |
| **Availability of a quiet coach** | | | | | | | |
| **Reliability of train services** | | | | | | | |
| **Availability of catering services such as buffet car and/or trolley** | | | | | | | |
| **Easily accessible services in the station (e.g. information, ticket purchase)** | | | | | | | |
| **Easily accessible facilities (e.g. platforms, toilets)** | | | | | | | |
| **Easily accessible transport links to and from the station** | | | | | | | |
| **A waiting room at the station** | | | | | | | |
| **Direct train services (i.e. no changes)** | | | | | | | |
| **Ticket price** | | | | | | | |

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Q27. In terms of your journey today, how satisfied are you with the following?
Scale of 7=very satisfied to 1=not satisfied

| Statements | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| Availability of real-time information (on-line and at stations) | | | | | | | |
| Availability of *Wi-Fi* on trains | | | | | | | |
| Availability of *Wi-Fi* at stations | | | | | | | |
| Frequency of train services | | | | | | | |
| Able to guarantee a seat | | | | | | | |
| Electric power sockets | | | | | | | |
| Availability of a quiet coach | | | | | | | |
| Reliability of train services | | | | | | | |
| Availability of catering services such as buffet car and/or trolley | | | | | | | |
| Easily accessible services in the station (e.g. information, ticket purchase) | | | | | | | |
| Easily accessible facilities (eg platforms, toilets) | | | | | | | |
| Easily accessible transport links to and from the station | | | | | | | |
| A waiting room at the station | | | | | | | |
| Direct train services (i.e. no changes) | | | | | | | |
| Ticket price | | | | | | | |

***About Yourself (for classification purposes)***

Q28. Gender
- ☐1 Male
- ☐2 Female

Q29. In what age group do you belong?
- ☐1 18 – 24
- ☐2 25 – 34
- ☐3 35 – 44
- ☐4 45 – 54
- ☐5 55 – 64
- ☐6 65 or more
- ☐7 Prefer not to say

Q30. How would you rate your agreement with each statement below?
Scale of 7=strongly agree to 1=strongly disagree

| Statements | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| I have the opportunity to work during my journey today. | | | | | | | |
| Working on the train is more productive than in the office. | | | | | | | |
| The journey seems to pass more quickly when I am using my personal electronic devices, such as a lap-top or iPhone. | | | | | | | |
| Delays are less frustrating when free *Wi-Fi* is available on board | | | | | | | |
| A small increase in travel time would be acceptable as long as free *Wi-Fi* is available on-board. | | | | | | | |
| A small increase in the cost of the ticket would be acceptable as long as free *Wi-Fi* is available on-board. | | | | | | | |
| The duration of this journey is too long. | | | | | | | |
| This train is comfortable. | | | | | | | |
| I worry about my personal safety when I travel by train. | | | | | | | |
| Travelling by train makes me nervous. | | | | | | | |
| Travelling by train is tiring. | | | | | | | |
| I sometimes feel unwell when travelling by train. | | | | | | | |
| I sometimes feel uncomfortable being around people I don't know on the train. | | | | | | | |
| I would encourage people to use this train service. | | | | | | | |

Q31. Annual household income (as a whole, including income of everyone in your household, before deductions for tax, National Insurance, etc.)
- ☐1 Up to £ 10,399
- ☐2 £10,400 up to £20,799
- ☐3 £20,800 up to £31,199
- ☐4 £31,200 up to £41,599
- ☐5 £41,600 up to £51,999
- ☐6 £52,000 or more
- ☐7 Prefer not to say

Q32. Please consider how you feel about the following statements.
Scale of 7 (strongly agree) to 1 (strongly disagree)

| Statements | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| I do not like to juggle several activities at the same time. | | | | | | | |
| People should not try to do many things at once. | | | | | | | |
| When I am at my office desk, I work on one project at a time. | | | | | | | |
| I am comfortable doing several things at the same time. | | | | | | | |

Q33. How many people are there usually in your household? ______________________

Q34. Employment Status
- ☐1 Employed
- ☐2 Unemployed
- ☐3 Self-employed
- ☐4 Retired
- ☐5 In full time education
- ☐6 Looking after home
- ☐7 Other (please specify)____________
- ☐8 Prefer not to say

| To be filled by surveyor | |
|---|---|
| Surveyor ID: ____________ | Date: ______________ |
| Code : ____________ | |

**Stated Preference Questionnaire**

Please consider the following: Imagine that you will make a similar journey with your current journey (one way). You have three options available: **Same as Now, Option 1 and Option 2.** For each scenario below, I would like you to consider the three options and indicate your preferences in the appropriate box. For example:

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | *£50* | *£15 more* | *£5 less* |
| **Travel Time** | *1 hour 20 minutes* | *10 minutes earlier* | *15 minutes later* |
| **Your choice** | | ✓ | |

=====================================================================

**Scenario 1**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+10%) | £______ *less* (-15%) |
| **Travel Time** | | ______ *minutes earlier* (-15%) | ______ *minutes later* (+20%) |
| **Your choice** | | | |

**Scenario 2**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+10%) | £______ *less* (-20%) |
| **Travel Time** | | ______ *minutes earlier* (-10%) | ______ *minutes later* (+5%) |
| **Your choice** | | | |

**Scenario 3**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+15%) | £______ *less* (-5%) |
| **Travel Time** | | ______ *minutes earlier* (-5%) | ______ *minutes later* (+20%) |
| **Your choice** | | | |

**Scenario 4**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+10%) | £______ *less* (-5%) |
| **Travel Time** | | ______ *minutes earlier* (-5%) | ______ *minutes later* (+10%) |
| **Your choice** | | | |

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**Scenario 5**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+20%) | £______ *less* (-10%) |
| **Travel Time** | | ______ *minutes earlier* (-10%) | ______ *minutes later* (+5%) |
| **Your choice** | | | |

**Scenario 6**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+20%) | £______ *less* (-10%) |
| **Travel Time** | | ______ *minutes earlier* (-15%) | ______ *minutes later* (+15%) |
| **Your choice** | | | |

**Scenario 7**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+15%) | £______ *less* (-20%) |
| **Travel Time** | | ______ *minutes earlier* (-15%) | ______ *minutes later* (+10%) |
| **Your choice** | | | |

**Scenario 8**

| | Same as Now | Option 1 | Option 2 |
|---|---|---|---|
| **Travel Cost** | | £______ *more* (+15%) | £______ *less* (-20%) |
| **Travel Time** | | ______ *minutes earlier* (-10%) | ______ *minutes later* (+5%) |
| **Your choice** | | | |

**This is the end of the questionnaire. Thank you for your help.**

## Appendix 2: Syntax for converting single line to multiline data input in NLogit 4.0

The conversion from single-line data in to multi-lines data was conducted by writing a script in the NLOGIT software using the following syntax.

```
-->  READ;FILE="H:\SPdata.xls"$
--> CREATE
        ;Same=(choice=1);MCLT=(choice=2);LCMT=(choice=3)
        ;cset=3
        ;alt1=1;alt2=2;alt3=3$
--> WRITE
        ;id,alt1,cset,same,csame,tsame,
        id,alt2,cset,MCLT,cMCLT,tMCLT,
        id,alt3,cset,cLCMT,cLCMT,tLCMT
        ;File=H:\SPdata.txt
        ;Format=((6(F8.3,1X)))$
```

The syntax can be explained as follow:

1. READ Command: This is to locate the dataset.
2. CREATE Command: This is to create a multiline data set for three choice alternatives *Same*, *More Cost Less Time* (*MCLT*) and *Less Cost More Time* (*LCMT*)
3. WRITE Command: This is to write a multi-line dataset as shown in Table 10.2.