Understanding the links across Commuting, Travel Satisfaction and Well-being

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ABSTRACT

This study examines the potential link across commuting, travel satisfaction, subjective well-being, and overall well-being in the city of Cardiff with a view to developing a framework for the improvement of commuters' well-being within the area.

Recent evidence provides some proof of the link across commuting, travel satisfaction and well-being, but this has only lately emerged in the international literature. Moreover, previous studies and related analyses have been heavily reliant on cross-sectional data between either commuting and travel satisfaction or commuting and subjective well-being with the link across commuting, travel satisfaction and subjective well-being primarily missing. Using a novel, real-time, online smartphone-based longitudinal survey, the temporal context of commuting characteristics and travel satisfaction on subjective well-being is investigated.

The findings from the study suggest that travel satisfaction is positively associated with well-being, indicating that the more people are satisfied with their travel the higher their well-being. The socio-demographic characteristics of respondents is a significant predictor for their travel satisfaction and well-being, with age and income being of notable importance. People in the midlife age were the unhappiest and higher income does not always mean more happiness within the study. Also, the relationship across household cars, travel satisfaction and well-being was discovered to be paradoxical – more cars in the household meant lower travel satisfaction ratings but higher levels of well-being. Active commuters were the most satisfied commuters in the study with cycling commuters being the happiest. Car commuters were the unhappiest, ranking lowly for both satisfaction with travel and well-being. While commute time negatively influence both travel satisfaction and well-being, the influence of commute distance on travel satisfaction and well-being was heterogenous. Finally, people's moods were generally positive all through their journey, but their concentration levels drop later on at their destination resulting in them becoming less active and more tired at work and/or home.

These findings suggest that policies that promote full multi-modal travel while restricting car use will help focus people's attention on other travel modes within the city, shaping and/or changing their travel behaviour in turn.

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CHAPTER 1: INTRODUCTION

1.1 Background to the Study

Through the years, the evolution of human societies has been attributed to the connection between mobility and transportation. From the moment the earliest man wandered from his cave dwelling thousands of centuries ago, to set up civilizations within the Tigris and Euphrates valleys, human and technological advancement, as well as physical and social well-being, have rested on the potential of human beings transporting themselves, and their goods and services from one point to the other. A such, transportation has always been a mainstay in how people evolved which ultimately makes it a necessity to life.

A person's well-being can be described as the state of being content, healthy and/or successful brought about by a general feeling of happiness, and fulfilment. There is no consensus in literature on a particular definition for well-being due to the differences in the opinions of authors on the subject matter. Nevertheless, they all agree that the well-being of an individual involves the presence of positive emotions, feelings and moods such as happiness and contentment, and an absence of negative emotions, feelings and moods such as agitation, depression and unhappiness (Deci and Ryan 2006; Diener 2009; Ryff 2014).

Traditionally, urban planners, engineers and economists have dominated transportation planning policies and decision-making processes. However, transport planning has come to benefit immensely from the inputs of the field of sociology and psychology. Over the past 40 years, this interdisciplinary approach to modern planning has brought about more significant contributions to knowledge and an increased optimization of global transport systems (Stokols and Novaco 1981; Novaco et al. 1990; Scharff et al. 1992). Recently, there have been some research into the cause and effect of well-being, as well as its relationship with liveability due to the numerous effects it has on people and their livelihood. In literature, physical health and longevity, productivity, and community spirit amongst others, have shown vast improvements when connected with higher levels of well-being (Wener et al. 2003; Wener et al. 2005; Ettema et al. 2010; Delbosc 2012). This new interest in the role transportation plays on people's well-being has generated a whole new field of research over the last 20 years.

Studies have shown that travel behaviour can affect the well-being of a person favourably or adversely. Ettema et al. (2010) observed that positive or negative feelings can be experienced by individuals when undertaking daily travel for out-of-home activities. This tends to influence the individual's needs satisfaction and goal realisation, all of which ultimately affects their well-

being. Furthermore, when these trips involve mode transfers, they may become quite complicated resulting in increased levels of stress experienced and affecting their satisfaction with the travel negatively (Wener et al. 2003). Also, the capacity of an individual to be mobile can affect their wellbeing. Individuals with greater mobility have been known to exude feelings of freedom, competence and belonging as well as confidence in their abilities to achieve certain goals (De Vos et al. 2013; Nordbakke and Schwanen 2014b). Whereas, the inability to participate in activities due to a form of transport disadvantage may adversely lower the individual's sense of well-being and trigger feelings of social exclusion (Currie et al. 2010; Delbosc and Currie 2011). Asides from the aforementioned, some studies have shown that the characteristics of people's lives have some influence on their travel mode choice, which in turn influence their satisfaction with travel and how they evaluate their lives in general (Argyle 1999; Dolan et al. 2008; Gao et al. 2017b; Dolan 2019). Moreover, some studies have also shown that people's satisfaction with travel and well-being can be affected by their residential neighbourhoods as well as their accessibility to basic services, public transport, and green spaces within that neighbourhood (Feng et al. 2018; McCarthy and Habib 2018).

Commuting as a form of daily travel activity has also piqued the interest of researchers in the travel and well-being field. Daily travel is often necessary for meeting people's basic needs and could have a significant impact on their overall well-being. Commuting on the other hand helps people meet their need to pursue a career or provide for themselves and their families, and its importance to well-being cannot be overemphasized. Nevertheless, commuting represents the greatest proportion of travel time in people's daily travel and is associated with poor travel conditions whether as car or public transit commuting (Mokhtarian et al. 2001). Therefore, commuting is associated with physical, mental, economic and environmental costs for individuals as well as on the society.

The number of studies on commuting and well-being has steadily been on the increase over the last 20 years due to the influence health (physical and mental health) and commuting have on each other. Whether associated with walking, driving and cycling on roadways or with the use of public transit, commuting has much relevance to the health and social sciences, urban planning, engineering, economics, and business management. Moreover, the association between commuting and well-being also has an impact on potential uses in policies and decision-making process which is key to developing a sustainable transportation system (Mihyeon Jeon and Amekudzi 2005).

1.2 Justification for the Research

Travel and well-being research has recently seen a growing number of studies investigating the relationship between several travel characteristics such as travel mode, travel mode transfer, travel distance, and travel time, amongst others, with subjective and overall well-being (Abou-Zeid 2009; Bergstad et al. 2011; Ettema et al. 2011; De Vos et al. 2013; Olsson et al. 2013; Mokhtarian et al. 2014; Legrain et al. 2015). However, the empirical work is still limited as far as travel and well-being research is concerned. As mentioned earlier, well-being is a relatively new adoption to transportation planning and travel studies, as such the extent to which travel contributes to well-being is still being studied by researchers in the field. Initially, there was the issue of measuring well-being in research. This arose because well-being is a latent variable, therefore it cannot be quantified as a tangible element (Kahneman 1999; Kahneman et al. 1999). However, with the progress in well-being research, various measures of well-being were developed and subsequently validated for use (Diener et al. 1985; Kahneman et al. 2004; Diener et al. 2010; McMahan and Estes 2011b). This progress led to similar breakthroughs in measuring travel concepts by transport researchers. Some of these well-being measures were adapted into travel researches resulting in previously unmeasurable variables finally being able to be measured (Ettema et al. 2011; Friman et al. 2013).

When it came to research specifically in commuting, previous studies and related analyses have been heavily reliant on cross-sectional data between either commuting and travel satisfaction or commuting and subjective well-being with the link across commuting, travel satisfaction and subjective well-being primarily missing. Unlike previous research efforts, this research will work towards formalising the relationship across commuting, travel satisfaction, subjective- and overall well-being while also exploring the spill-over effects of commuting on both work life and family life.

This research is aimed at capturing and explaining the effects of commuting characteristics such as commute time, commute mode and commute distance and travel satisfaction on subjective well-being via a temporally dynamic approach. In this regard, this study will develop and implement a longitudinal data collection approach – i.e., repeated observations of commuting patterns and travel satisfaction instead of the use of a cross-sectional survey synonymous with most studies in travel and well-being research. Using this approach, the research will be able to analyse, among other things, the influence of multiple satisfying (or dissatisfying) journeys and/or activities over time on commuters' positive (or negative) evaluation of their well-being. This is because it is assumed that people's overall well-being

can be influenced by the accumulated effects of other domain-specific activities, in this case daily travel (Hennessy 2008; Ettema et al. 2010; De Vos et al. 2013). Furthermore, empirical evidence from the measurement of subjective well-being in activities and travel has been able to indicate that travel plays a role in people's overall well-being (Ettema et al. 2010; Delbosc 2012), and the time-period well-being is measured matters due to its dynamic nature (Larsen and Fredrickson 1999; Kahneman and Krueger 2006). Thus, this research both fills a gap and complements existing knowledge.

Asides from the aforementioned motivations, this research also stems out of the researcher's personal interest in travel, travel satisfaction and well-being. As an urban planner who grew in one of the world's most populous cities (Lagos, Nigeria), urban travel issues were rife and presumed as a mainstay of city living only to be coped with. This resulted in a personal dissatisfaction with urban travel and its associated issues which in turn led to questions on how these ultimately affected the physical and mental health. As well as bridging an identified gap in literature and developing a novel approach to data collection within the subject area, this research also helps the researcher understand some personal queries into travel and well-being.

1.3 Research Aim and Questions

This study seeks to examine the potential links across commuting (and its characteristics i.e., commuting time, commute distance mode and commute mode), travel satisfaction, subjective well-being, and overall well-being.

The study begins by examining the relationship between travel satisfaction and well-being. After this relationship has been ascertained, the study proceeds to investigating the connections across various commuting characteristics with travel satisfaction and well-being. The commuting characteristics studied were commute mode, commute time and commute distance. The third question then investigates the influence of socio-demographic characteristics on travel satisfaction and well-being. These socio-demographic characteristics would include gender, age, income, number of people in household, amongst others. Afterwards, the study explores the spill-over effects of the commute experience. The study concludes with an exploration of the relationship across commuting attitudes, travel satisfaction, well-being and neighbourhood quality.

In sum, the research is designed to answer the following questions:

i. What role does an individual's satisfaction with daily travel play on their subjective and overall well-being?
ii. What role does the individual's commuting characteristics (i.e., commute time, commute distance and commute mode) play on travel satisfaction and subjective well-being?
iii. How has the socio-demographic conditions affected the travel satisfaction of individuals, and have these conditions affected their subjective well-being?
iv. What role has the individual's commute experience played on their moods?
v. Is there any association across the individual's commuting behaviour, travel satisfaction and subjective well-being? and
vi. How has access to basic amenities, a good neighbourhood, and urban transportation infrastructure and resources influenced commuting patterns and behaviours?

These research questions all stem out from consideration of the various variables (factors, activities, and conditions), such as commute characteristics, socio-demographic variables etc., that have been identified as being of critical significance to influencing travel (especially commuting) and well-being. However, where this study differ from other similar studies is that it employs a real-time online data tracking measure to record travel satisfaction, commute distance, commute time, mood and well-being over a period – one of the first studies in travel and well-being research to do this.

1.4 Outline of the Thesis

This thesis is divided into six chapters the details of which are provided below:

Chapter 1 – Introduction

This chapter provides a background information and general description of the of the concepts being studied. Here the thesis introduces travel and well-being highlighting its importance to modern transport planning and policy. This chapter also describes the rationale for the study, identifies the problem to be solved, elaborate on the gap to be filled, discusses the aim and research questions, before outlining the structure of the thesis.

Chapter 2 – Literature Review

Chapter 2 further explores the concepts of travel and well-being introduced earlier focussing on a review of previous literature necessary for understanding what these concepts entails

vis-à-vis their definitions, delineations, determinants and measurement tools. The thesis further provides a basis for the theoretical and conceptual framework later discussed. Ultimately, the chapter aims to expatiate on the current situation regarding the linkages across commuting and its characteristics, socio-demographics, and travel satisfaction while also addressing the inadequacy of knowledge the current well-being literature suffers from.

Chapter 3 – Research Design and Methodology

This chapter provides a description of how the study was designed and implemented. An overview of selected empirical research into commuting, travel satisfaction and well-being (including methods adopted) are also provided which form the basis for the methods adopted in this research. It also discusses the variables to be measured, the measurement instruments employed, the sampling procedure adopted as well as the details on how the study was conducted. Also, the techniques employed for analysing the data collected was briefly summarised in the chapter. A profile on Cardiff, the study area adopted for the research, is also provided earlier in the chapter. This includes a summary of the geography, economy, commuting patterns and travel characteristics of the study area.

Chapter 4 – Analysis and Presentation of Results

This chapter presents the findings from the research. These findings are divided into two main categories: findings from descriptive analysis, and findings from inferential analysis. The descriptive analysis focusses on the use of measures of central tendencies (precisely frequencies and percentages) to better understand nuances in the population especially as regards variables such as the socio-demographic characteristics, commute patterns / behaviours, and neighbour quality amongst others. The inferential analysis explores the dimensions of travel satisfaction and well-being in the context of the various determinants such as commute time, commute distance, commute mode and socio-demographic characteristics, as well as exploring the spill-over effects of commuting on the population. Also, five measurement scales are adopted in the study: a mood scale, the Satisfaction with Travel Scale (STS), the Satisfaction with Life Scale (SWLS), a commuting behaviour scale, and a neighbourhood quality scale. The chapter provides a summary of the reliability test conducted to estimate the internal consistency for each of these scales to determine their relevance and quality to the study.

Chapter 5 – Discussion of Findings

This chapter consolidates the research findings discussing the related evidence obtained from the analysis. The chapter attempts to draw parallels between the findings from the study and findings from similar studies while also providing compelling arguments for the reasons these findings were observed. Summarily, the findings from the study suggests that the determinants for travel satisfaction and well-being in the study are commute time, commute distance, commute mode, socio-demographic characteristics, commuting attitudes and behaviours, and neighbourhood quality. Furthermore, the chapter also discusses the results of the commute experience on the individual's mood indicative of the spill-over effects of commuting.

Chapter 6 – Conclusion

This chapter concludes the thesis by highlighting the study's contribution to travel and well-being research. It identifies several measures that can be adopted to better improve commuting and well-being within the city of Cardiff. It also provides a discussion on the policy implications of the findings especially as it relates to the city of Cardiff. It concludes with a summary of the research limitations experienced from conception to completion of the research and provides some suggestions for future research within the field.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This aim of this chapter is to systematically build a conceptual framework that connects travel and well-being. To start with, literature on travel and well-being were few and far between with most lacking a detailed overview of what the concept of well-being entailed. Therefore, to properly connect travel with well-being, there needed to be a thorough examination of what well-being was and what well-being was not. First this chapter introduces the concept of well-being, discussing its definition, categories, determinants and measurements. Afterwards, an overview of the interdisciplinary literature on well-being is presented before connections are established between travel and well-being. This helps to understand the research undertaken in the thesis to bring the literature on well-being into a comprehensive whole. This chapter attempts to fill a substantial gap in the literature by providing a detailed review of the extant literature related to well-being and then relate this to travel.

This literature review is broadly divided into sections; well-being and what well-being entails, and travel and well-being and what it entails. These two sections form the basis of the theoretical and conceptual underpinnings the research discusses for devising a new survey tool later in the methodology chapter. More specifically, the first section of the chapter begins with a definition of well-being, then proceeds to describe the types of well-being there is. Next is a discussion on the correlates of well-being, then a summary of how well-being is measured and its measurement tools. A concise description of measurement issues associated with well-being comes next before rounding off with some discussion on well-being and public policy. The second section begins with an exploration of travel and well-being including its related concepts, then it proceeds to give an overview of the determinants of travel behaviour in relation to well-being. This is followed by a discussion of the measurement tools that have been adopted in travel and well-being research. The theoretical and conceptual underpinnings of the research are discussed briefly. An overview of the spill-over effect of travel and commuting is also presented before the chapter concludes with a summary.

It is important to clarify that a large number of literatures discussing the concept of well-being have come from sources that are quite dated by today's standard. This is because many of the studies into well-being were conducted in the years between late 1980s and the early 2010s. However, where possible more recent sources have been cited to achieve a fair balance when discussing well-being. In addition, more recent literature that discusses the

connections between travel and well-being have also been included in this review. Therefore, this review has also endeavoured to contribute to existing knowledge of well-being and travel by bridging the gap between old and new.

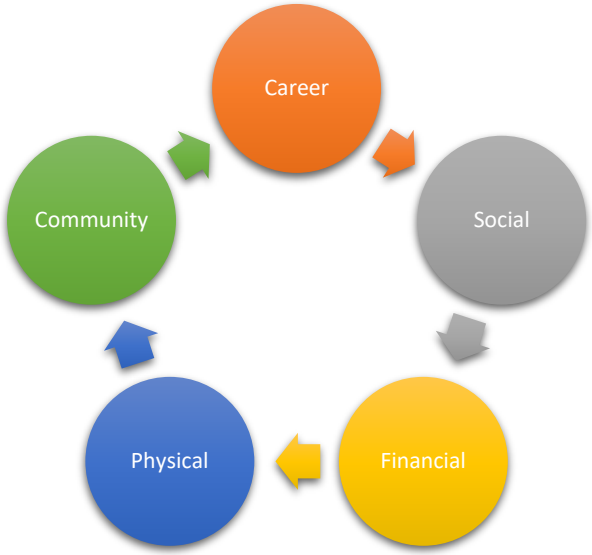
2.2 Well-being

2.2.1 Definition and Types of Well-being

Well-being and research into its nature, cause and effects has long been associated with the field of psychology. Historically, philosophers such as Aristotle and Epicurus were among the very first to study the concept and their works have impacted contemporary studies on the subject. In popular culture, the term well-being usually refers to health and healthy living. This refers to all aspect of the individual's life and includes physical, mental as well as the psychophysiological health. However, the conceptual meaning of the term has long elicited debate in the academic world.

It is important to point out here that well-being has acquired a localised term and thus, it has always been described (or defined) in the context of the use it is being described. For example, a psychologist might use the term to describe the mental activities and processes of the human nature, or a sociologist might relate this term to mean a person's social quality and engagement, while an economist might mean the financial competence of a person or nation. Rath and Harter (2010) argued that these delineations were merely facets of a whole when they posited that well-being composed of five elements namely career well-being, social well-being, financial well-being, physical well-being, and community well-being (see Figure 2.1). From this perspective, it can be construed that if a person has a good job, have some friends, is quite comfortable financially, is healthy and is respected within their local community, it is logical that the person is assumed to have a high level of well-being. However, well-being entails more than these elements as we will see shortly.

Figure 2.1: Elements of Well-being



Source: Rath and Harter (2010)

Bradley (2015) attempted to define well-being by breaking it into three concepts:

i. **Well-being and happiness** – he opines that because happiness is tied to a mood or feeling we experience, then if well-being is to be associated with happiness, well-being should be associated with us feeling good. He called this 'experiential happiness' and concluded that this does not sufficiently define well-being.

ii. **Well-being and goodness** – goodness is divided into intrinsic goodness, which is goodness in itself, and goodness which is a notion of well-being. Bradley suggested that because something is good intrinsically does not mean it is good for the person. Moore and Baldwin (1993) aptly connects intrinsic goodness with well-being when they noted that since the experiencing of happiness by someone is good for that person, therefore, a world with the person experiencing happiness is a better world. Therefore, the person's experience of happiness is good for them. However, Bradley (2015) was quick to critic this view suggesting that something can be intrinsically good and make the world a better place but be bad for the person, e.g., the capital punishment for a serial killer makes the world a better place but means death for the individual. Again, this does not sufficiently define what well-being is.

iii. **Well-being and caring** – the idea behind this is, well-being is defined based on what you would want in the life of someone you care about. The issue in this definition arises when what we want for the person may not be what is best for them. Therefore, this

clause, ‘for their own sake’, is added into the definition. In sum, well-being in this context is described as what we want in the life of someone we care about that is best for their own sake (Darwall 2002).

Bradley concluded that these concepts in themselves could not adequately define the term well-being, however, it is important to see the connections between them. Moreover, if these different concepts of well-being are consolidated; well-being can be described as happiness, which in its broadest sense means flourishing, something which is good in itself and makes the world a better place, and it is one of the most important things we want for those we care about.

In this same vein, well-being has come to be synonymous with happiness in the fields of philosophy and psychology. This may be because classical philosophers and psychologists defined well-being in this context, and this has trickled down to how the concept in viewed today. Scholars and researchers of well-being in the said fields have long believed how well-being can be explained. This review has differentiated them into three broad concepts namely emotional well-being, prudential well-being and psychological well-being (Diener 1984; Diener et al. 1985; Lucas et al. 1996; Sumner 1996; Diener et al. 1999; Veenhoven 2000; Ryan and Deci 2001; Seligman 2004; Kesebir and Diener 2009; Sirgy 2012) and these are succinctly summarised below:

i. **Emotional well-being** – This is also known as hedonism or psychological happiness. As the name implies this type of well-being is related to feelings and emotions, also called affects (Diener 1984), which are elements of the term ‘subjective well-being’ as proposed by Ed Diener in the mid-1980s. Hedonism is centred on self-gratification and it involves a person’s maximizing their positive affect and minimizing negative affect to obtain the highest possible level of happiness.

ii. **Prudential well-being** – Well-being as described here relates to the cognitive and evaluative aspects of well-being. Whenever we compare our lives at any particular moment to a set of appropriate standards in terms of needs, goals, and achievements we engage the cognitive elements of subjective well-being (Sirgy 2012). Our life satisfaction at this moment is determined by our perception of our current state measured against an appropriate standard. In sum, we are happy whenever we are satisfied with the current, past and future conditions of our lives as a whole at any given moment (Sumner 1996). Hence, prudential happiness has been referred to as life satisfaction which was combined with hedonism by Ed Diener to coin the term

subjective well-being. He described this as the presence of positive feelings, the absence of negative feelings and the overall satisfaction with life (Diener 2009). There has been arguments that hedonism is necessary for prudential well-being but it is however not a sufficient condition for it (Waterman 1993). As such, happiness is more than just emotional well-being / hedonism and this cannot be the only element of the good life (Deci and Ryan 2006; Kesebir and Diener 2009). Which leads us to the last concept.

iii. **Perfectionist well-being** – This has also been described as eudaimonia, flourishing life, meaningful life and psychological well-being (Ryff 1989; Waterman 1993; Ryan and Deci 2001). This is based on the works of the ancient Greek philosophers Aristotle, Plato and Socrates all believing that to lead a happy life is to lead a moral and purposeful life. This concept has been argued to go far and above the concept of subjective well-being as described by Ed Diener (Deci and Ryan 2006; Sirgy 2012). This is because in addition to its focus on subjective well-being, it also touches on moral and personal development and the fulfilment of one's true potential. Seligman (2004) aptly summarises this when he opines that authentic happiness consists of a hedonistic well-being, life satisfaction and an eudaimonic well-being.

This section attempts to surmise and present the various views surrounding what researchers in the fields of philosophy, sociology, and psychology describe well-being to mean. The nebulous sea of meaning is distilled into concepts that can be understood by researchers from other fields. The different types of well-being are presented next.

2.2.2 Subjective and Objective Well-being

Over the years, well-being has become synonymous with happiness, and these two terms have been used interchangeably (Kahneman 1999). Happiness is divided into subjective happiness, assessed by asking people to report on their happiness, while objective happiness is assessed on a record of how happy the people are at a particular period as viewed by another person using a metric.

Sumner (1996) would argue that both subjective and objective happiness could be merged and termed the 'life satisfaction view of well-being'. It is believed that how well-off a person is at any given time is a function of the person's degree of satisfaction at that time about their whole life. Furthermore, being satisfied with your life entails two components; an experiential component which involves being fulfilled, and a cognitive component which entails the

judgement that your life is going on well according to your own standards. In all, it is believed that since subjective well-being is about feelings, emotions, personality and beliefs, this taps into the individual's frame of mind and is different from objective well-being associated with such indicators as crime, health, income etc., and are external to the individual.

This view sits well with a similar study which observed that well-being is about experiential happiness and consists of three components; the presence of positive feelings, the absence of negative feelings and the overall satisfaction with life (Diener 2009). As discussed earlier, this primarily consists of two aspects, an affective domain (positive and negative affect / happiness) that veers towards feelings and emotions, and a cognitive domain (life satisfaction aspect) that is related to reasoning, perception and judgement. Although these two aspects are very different from each other, there is however a significant overlap in their conceptualizations since they are elements of the same construct – subjective well-being.

Furthermore, the differences in them can be explained by their various contributing factors. Studies have consistently shown that the presence of family and having fun times together contributes more to the affective than cognitive domain; whereas health, assets, economic and financial securities enhanced life satisfaction more than happiness (Veenhoven 1995; Saris and Andreenkova 2001). However, it has been observed that different aspects of the characteristics that make up people's lives such as financial security (income) or family (having children) elicit a different response to the norm (Haller and Hadler 2006). An increase in income increases the affective and not the cognitive domain and having children increases cognitive and not affective domain. An explanation for this might be that since cognitive experiences are evaluated against some set standards, having children would be evaluated based on comparison with others and increase in income would just reduce dissatisfaction and increase happiness (Inglehart and Rabier 1986; Haller and Hadler 2006).

In terms of public policies, both the subjective and objective aspects of well-being should be considered. Objective indicators such as crime, pollution, socio-demographic characteristics, etc., have long been used by policy makers as policy indices however, more attention should be given to subjective indicators. Especially as perception and judgement which are elements of cognitive domain (an important denominator for subjective well-being) are reflections of the population's personal experiences (Michalos 2008; Graham 2012). Policy and well-being is revisited later in the chapter. Moreover, as discussed earlier, subjective well-being has generated so many interests from well-being researchers to the point that it has become synonymous with the term well-being, so much so that it has been used interchangeably. This use is similar in this thesis; unless where specifically stated, subjective well-being is used

interchangeably with well-being and vice-versa. Going forward, subjective well-being can further be divided into hedonism and eudaimonia.

2.2.2.1 Hedonism and Eudaimonia

As studies continue to explain the concept of well-being, the well-being of the individual has come to be viewed as personal and subjective to the individual's way of living. This is then explained by behaviours and circumstances surrounding the individual and is affected positively or negatively by changes to these behaviours and circumstances. Eventually, happiness came to be viewed (and synonymous) with subjective well-being and subsequently well-being (Argyle 1999; Diener et al. 1999; Diener 2009; De Vos et al. 2013).

Leading from this, two school of thoughts, hedonism and the eudaimonia, exists on the forms of subjectively experienced well-being that exists. The former establishes that well-being consists of positive moods, pleasure and/or the experiences of bliss (i.e., experiential happiness) and contentment and an individual will always strive to satisfy and maximise their well-being (Diener et al. 1999; Kahneman et al. 1999; Diener 2009). However, the latter school of thought view well-being as more than experiential happiness and preference satisfaction by emphasizing purpose in the meaning of life, personal growth and a realisation of the best in one's life (also called flourishing) (Ryff 1989; Ryan and Deci 2001; Deci and Ryan 2006; Ryff 2014). Perhaps the most concise definition for well-being based on eudaimonia is from Waterman et al. (2010) stating that eudaimonia is 'identifying one's potential strengths and limitations and choosing those goals that provide personal meaning and purpose in life' (p. 42). It has been argued that the subjective nature of well-being comes from the fact that people evaluate themselves based on the three delineations of experiencing a high degree of positive affect, a low degree of negative affect and a high level of satisfaction with life (Diener 2009). However, Deci and Ryan (2006) opined that the precise interpretation of hedonism would be to use only positive and negative affect to denote happiness because life satisfaction is a cognitive evaluation of one's life and is not hedonistic in nature.

Eudaimonia entails more than just happiness. In fact, it has been suggested that even when people report high ratings of happiness, this does not necessarily translate to having significant high ratings for psychological well-being (Deci and Ryan 2006). Waterman (1993) describes eudaimonia as being concerned with living well and realising one's true potentials. This concept maintains that well-being is the process of fulfilling one's true potential as against an outcome or end state where happiness is emphasised.

An important thing to note here is that there is believed to be a significant intertwine between experiencing hedonism and eudaimonia (as previous studies have used these concepts interchangeably). However, if a person experiences eudaimonic living, they will also experience hedonic enjoyment, but not all hedonic enjoyment comes from an eudaimonic life (Waterman et al. 2006). While hedonism is defined as the positive feelings that accompany getting the material things one wishes for, eudaimonia entails making the right choices as against being drawn into excesses such as materialism (Deci and Ryan 2006; Waterman et al. 2006).

Perhaps of great importance to note is that unlike hedonism, various authors and researchers have described eudaimonia as it best fit their usage. There is no particular theory, concept or methodology for eudaimonia as each successive author / researcher only builds upon previous works (Huta and Waterman 2014). Nevertheless, a review of literature indicates that Carol Ryff's psychological well-being model have been generally used in its original form or a variation of its original to study the relationships between well-being, physical and mental health, family and occupational lives, personality traits and life cycle changes (Ryff 1989; Ryff and Keyes 1995; Ryff and Singer 2006; Ryff 2014). Eudaimonia according to the author involves six characteristics of psychological well-being namely self-acceptance, relatedness, autonomy, personal growth, purpose in life, relationships and environmental mastery. And these have distilled down into eudaimonic interpretations of well-being today.

Recently, some significant overlap has been observed between the two different types of subjective well-being. Studies using the subjective well-being model designed by Ed Diener to measure hedonism and Carol Ryff's psychological well-being model to measure eudaimonia observed a strong positive relationship between hedonism and eudaimonia indicating that these two concepts are not separated from each other (Gallagher et al. 2009; Linley et al. 2009; Fredrickson et al. 2013). An explanation for this substantial overlap is that hedonism and eudaimonia seem to be the same well-being construct due to their very similar general elements and concepts. Furthermore, current well-being studies have gradually evolved the meaning of happiness from hedonism to include traditional eudaimonic aspects such as personal fulfilment and self-actualization (Disabato et al. 2016).

In real life experiences (and in research), hedonism has become more associated with subjective well-being while eudaimonia is to psychological well-being. It is therefore imperative that before decisions concerning well-being are made by policy makers, the understanding of what they each entail and how they affect the goals of individual members of the society is considered (Disabato et al. 2016). Furthermore, since happiness can both be viewed as

maximizing the greatest pleasure for oneself (hedonism) and as flourishing and leading a purposeful life (eudaimonia), policies that would put into consideration these various types of happiness should be encouraged. For instance, it has been advised that policies that encourage self-actualization and ultimate potential fulfilment (educational system reforms, health care upgrades, improved transportation services and facilities etc.) should be prioritized since these policies contribute to the leading of a purposeful life rather than bringing about happiness on the short term (Graham 2012).

In sum, the concept of well-being has over the years come to develop into a very important area of study cutting across various fields in both academia and policy formulation. While the review of literature indicates that there is no consensus on a definition for well-being due to the disparity of authors' opinions on the issue, it is advocated that well-being be interpreted in its definitive state to mean what the author desires, as it may be one of those basic and undefinable concepts that exists (Larsen and Fredrickson 1999; Bradley 2015). It has been established that happiness and life satisfaction is based on subjective well-being, however, this has gone far and above to include living a meaningful life, and self-actualization – all of which are essential elements of psychological well-being or eudaimonia (Sirgy 2012).

2.2.3 Determinants of Well-being

As observed by Larsen and Fredrickson (1999), the contents of a person's life strongly influences their judgements of the quality of that life. Studies have shown that the socio-demographic factors are one of the major determinants that influence the way individuals evaluate their quality of life and life satisfaction (Diener 1984; Argyle 1999; Blanchflower and Oswald 2008; Gao et al. 2017a; Wu et al. 2019). It is therefore important to consider this when looking at correlates of subjective well-being. The following are some of the socio-demographic factors that influence well-being:

i. **Age** – Some studies have discovered that as they age, men become more happy while women are happy less of the time (Blanchflower and Oswald 2004; Dolan et al. 2008). Several studies have also shown that older people are more satisfied with their lives in general as compared with younger folks (Argyle 1999; Ziegler and Schwanen 2011; Green et al. 2014). While these studies have shown that an individual's ratings of overall well-being increase with age, some other studies have observed a more 'natural' U-shaped curve to exist between age and satisfaction with life, overall well-being and happiness. Several studies have reported that people generally are at their unhappiest between their late 30s and early 50s (mid-life doldrums) and are at their

happiest at the two extremes of the curve (when they are very young and when they are very old) (Blanchflower and Oswald 2008; Dolan et al. 2008; Gwozdz and Sousa-Poza 2010). There have been studies that try to explain the reason older people tend to be happier than younger folks. These studies opined that since older people have lower life aspirations, which make their goal-achievement gap smaller, they expect to be out of a job, or possibly widowed as against younger people which suggests an adjustment in their aspirations (Campbell et al. 1976; Inglehart 1990).

Importantly, this U-shaped relationship does not always apply to all real-world experiences as a study observed. Easterlin (2006) observed that the rating of subjective well-being gradually rises after the age of 18, peaks in midlife and starts to slowly decline from then on, resulting in an inverted U-shaped relationship. In explaining this relationship, it is opined that the individual's satisfaction with family and work life may have resulted in the rise in overall well-being while a deterioration in health and other failing conditions might explain the decline or dissatisfaction later on (Easterlin 2006,2010). Moreover, it has been argued that this inverted U-shaped relationship only remains true in consideration with health and well-being as every other life domain follows the U-shaped relationship (Van Praag and Ferrer-i-Carbonell 2011).

ii. **Education** – Studies have found a correlation between education and subjectively experienced well-being. In Europe and the USA, the effect is quite small and this is getting weaker, whereas, the effects are more evident in developing countries such as Mexico and Nigeria (Campbell 1981; Veenhoven 1995). Since education is often linked with income and occupational status, a negative effect between education and income can be observed because education creates expectations for a higher income (Campbell 1981; Clark and Oswald 1996). Clark and Oswald (1996) further explains that education can help achieve eudaimonia (self-fulfilment and potential actualization) which greatly improves well-being levels. However, the study also noted that education can cause aspirations to soar so high that they become unattainable thereby reducing the individual's ratings of well-being. Another study further observed that individuals feel and record higher well-being ratings when they recognise that they are more educated than others within a group (del Mar Salinas-Jiménez et al. 2011). As such, it is possible that education can elicit both positive and negative effects on people's well-being.

iii. **Income** - Diener (2009) suggested that income is more closely related to the cognitive aspect of hedonism (life satisfaction) than with its affective component. It has been observed that individuals and regions possessing relatively more affluence than their counterparts are significantly happier (Blanchflower and Oswald 2004; Dolan et al. 2008). The reason for this is that an increase in income brings about a corresponding increase in self-esteem, optimism and control, all of which have been associated with improving positive affect and increasing overall well-being (Cummins 2000; Wu et al. 2019). Veenhoven (1995) observed that a strong correlation exists between income and happiness for developing countries, while there are varying results for Europe and the USA. Furthermore, a strong correlation is noticed in Europe while a weak one was observed in the USA. Findings from several studies also reveal that citizens of more affluent countries are happier than citizens in less affluent regions because affluent countries possess a level of "individualism" not found in less affluent regions which enables their population to pursue their goals freely, increasing self-actualization and improving their overall well-being (Ahuvia 2002; Dolan 2019).

Studies have also shown that an increase in income only make citizens of poorer countries happier and does little or no effect to citizens in richer regions (Dolan et al. 2008; Lawless and Lucas 2011). Cummins (2011) attempts to explain this by suggesting that since poorer people / communities struggle to meet their basic needs and demands, an increase in income would greatly improve their immediate happiness and general well-being. Although it has been established that the possession of wealth is a condition for happiness, it is sadly not a sufficient criterion for its sustainability. The Easterlin Paradox explains this when it noted that as income increases over time, there appears to be no corresponding increase in happiness, and wealthy individuals are only happier than others with lower income for a while till diminishing returns set in (Easterlin 2010). This eventually results in a narrowing of the previously wide happiness gap between the rich and the poor. This corroborates claims from an earlier study which observed that within a geographical location, the very rich are happy 77% of time as compared to 62% by a comparison group which led to the coining of the term 'happy poor' which was interpreted to mean a state of adaptation and self-realisation that there would be some things people cannot possibly afford based on their means (Olson and Schober 1993). The pursuance of close relationships, personal growth and community relatedness are the goals that bring the utmost happiness in life not income and material possession (Kasser and Ryan 1996; Kesebir and Diener 2009). Furthermore, happiness in life is predicated on an evaluation of, and a

satisfaction with other life domains (family, work, health, leisure, and community life) and not just income/wealth.

iv. **Social and Community Relationships** – Forgas and Wyland (2006) observed that a greater sense of well-being brought about by general feelings of happiness brings out the absolute best in people – making them more ethical, cooperative, likeable and social. Further studies have observed that people who are generally happy are more likeable than people who constantly appear sad or depressed and a higher sense of morality and trustworthiness have been closely associated with how the society perceive happy people (Dunn and Schweitzer 2003; Forgas and Wyland 2006).

On a broader scale, there may be evidence to suggest that an individual's preferred location of residence significantly impacts their overall levels of well-being. Dolan et al. (2008) suggested that living in urban areas may affect an individual, reducing their sense of overall well-being while rural living may greatly improve this especially in some countries in Europe and South America. Conversely, some other studies have discovered that living in urban centres have a positive influence on neighbourhood satisfaction, personal relationships, and well-being in comparison with people who lived in suburban or rural settings (Feng et al. 2018; Mouratidis et al. 2019; Mouratidis 2020). An individual's social class has also been observed to affect their ratings of well-being. However, this has more effect on happiness in developing countries where higher inequalities of income are the trend, as against developed countries in which happiness inequality has greatly reduced and its difference has almost disappeared (Argyle 1999).

v. **Marriage, Marital Status and Family Life** – According to Shapiro and Keyes (2008), marriage has often been found to be one of the strongest correlates of happiness and well-being. Argyle (1999) noted that people who are married or living together are on average in better physical and mental health than any other related demographic group. Younger couples exhibit the highest ratings for well-being which is attributed to the passionate love they experience (Haring-Hidore et al. 1985). DeLongis et al. (1988) opined that happily married people are least likely to report physical and mental health problems as against married people in an unhappy relationship. Furthermore, most patients in mental hospitals have been observed to be unmarried (never married, divorced, separated or widowed) (Kalmijn and van Groenou 2005).

Even further evidence suggests that marriage not only affects the overall well-being of parents, but children are also affected. Children and adolescents living with two parents exhibits the highest ratings for subjective well-being while those residing with a single parent or no parent report lower well-being ratings (Kwan 2008). Amato and Sobolewski (2001) further discovered that adults who grew up in separate homes or with divorced parents are at risk of experiencing lower standards of living, lower marital satisfaction, poorer health, having less education, lesser job status, a generally lower quality of life all translating to lower ratings of well-being.

vi. **Gender** – Gender differences have been consistently shown to occur in measures of well-being for both subjective and psychological well-being (Nolen-Hoeksema and Rusting 1999; Inglehart 2002; Roberts et al. 2011). Nolen-Hoeksema (1995) observed that women are more likely to suffer from severe depression and mild panic attacks than men, while the reverse is the case for men. Studies have revealed that women experience reporting and expressing emotions such as sadness, fear, shame, guilt and anxiety more often than men (Brody et al. 1990; Grossman and Wood 1993; Feingold 1994). Furthermore, studies have also shown that women report experiencing and expressing more positive emotions such as happiness, joy and love more often than men (Haring et al. 1984; Grossman and Wood 1993). Moreover, studies have discovered that women tend to start adulthood with a greater sense of well-being and happiness than men but eventually end their lives less satisfied (Plagnol and Easterlin 2008). Pinquart and Sörensen (2001) reasoned that women are more contented with their family and financial conditions at an early age as compared to men who achieve these satisfactions at a later stage in their lives, hence why this seems to occur.

A German study appears to shed more light to this situation when it observed that during the doldrum years (mid-life period) when overall well-being and happiness are at their lowest, women are the worst hit (Brockmann 2010). The lower levels of well-being reported by women with childcare responsibilities may also help explain the reason women are worse off during the doldrum years as it is assumed most women would have had children during this stage of their lives (Kwan 1999). This findings however raises some questions as evidence from earlier research discovered that contextual factors such as marriage improved the levels of well-being for both genders during this period with women exhibiting a higher degree of happiness than men (Wood et al. 1990). In sum, this disparity strengthens the case for inclusion of gender differentials in well-being studies.

vii. **Employment** - Argyle (1999) noticed that several aspects of happiness and subjective well-being such as positive affect, life satisfaction and self-esteem are affected by employment status. Unemployed people are often very bored, and very susceptible to depression, alcoholism and suicide (Argyle 1989). However, retired people are much happier – especially when retirement was voluntary, they are of sound health, and they pursue active interests and activities (Argyle 1996). The nature of an individual's work has also been found to affect well-being. Dolan et al. (2008) suggested there may be sufficient evidence to show that the most satisfying jobs are self-employment jobs while those working casual or blue-collar jobs are the least satisfied with their general well-being and happiness. Furthermore, being in full time employment was associated with higher levels of well-being than working in a part time employment situation (Dolan et al. 2008; Agrawal et al. 2011).

viii. **Ethnicity** – Studies have consistently shown that lower ratings of well-being were more reported among minorities as compared to other ethnic groups (Graham 2009; Graham 2012). Argyle (1999) suggested that the lower levels of well-being and happiness experienced among ethnic minorities can be attributed to their lower education, incomes, and job status. As regard work situations, even though there is little difference in the ratings of well-being for similarly educated employees in an organisation, ethnic minority employees still reported experiencing lower levels of well-being (Deitch et al. 2003).

ix. **Religion** – There is evidence to suggest that a belief in religion or a higher power is associated with greater levels of subjective well-being especially life satisfaction (Helliwell and Putnam 2004). Furthermore, a regular engagement in religious activities has also been found to significantly affect the ratings of subjective well-being, while also helping to insure against some adverse life events such as bereavement and loss of employment (Clark and Lelkes 2005).

x. **Personality** – It has been observed that emotions, temperament, and other personality characteristics such as extraversion, neuroticism, and self-worth can significantly influence levels of subjective well-being and evaluations of people's lives (Lucas and Diener 2009). For example, extraversion (interests in outward activities or external environment) appears to be more strongly related to positive emotions, while neuroticism (obsession with personal thoughts and feelings) is more related to negative feelings, and these personality traits do influence people's attitudes and behaviours (DeNeve 1999; Diener et al. 2003; Lucas and Diener 2009).

From the foregoing, asides from personality, the determinants of well-being are largely socio-demographic in nature. Other determinants of well-being include leisure activities, work and life events, neighbourhood quality and residential environments, (Argyle 1999; Ambrey and Fleming 2014; De Vos 2017; Ma et al. 2018). Furthermore, some significant relationships can also be found to exist between these determinants. These relationships, existing as a function of the interaction between the determinants and subjective well-being, have reverse associations with each other. This means that the effect they have can be either positive or negative depending on the context of the measurement. For example, various studies have shown that education can affect income both positively – by helping to achieve eudaimonia or life satisfaction (del Mar Salinas-Jiménez et al. 2011) and negatively – by creating expectations for higher income – see (see, Clark and Oswald 1996). Table 2.1 presents a summary of the association across identified socio-demographic determinants of well-being.

Table 2.1: The Relationship between the Well-being Determinants

	Associated Wellbeing Determinant								
Determinant	Age	Education	Income	Social and Communi	Marriage, Marital Status	Gender	Employment	Ethnicity	Religion
Age			✓	✓	✓	✓	✓	✓	✓
Education			✓			✓	✓	✓	
Employment	✓	✓	✓	✓	✓	✓		✓	✓
Ethnicity	✓	✓	✓				✓		✓
Gender	✓	✓	✓	✓	✓		✓		✓
Income	✓	✓		✓	✓	✓	✓	✓	✓
Marriage, Marital Status and Family Life	✓		✓	✓		✓	✓		✓
Religion	✓		✓		✓	✓	✓	✓	
Social and Community Relationships	✓		✓		✓	✓	✓		

Source: Author's Literature Review

2.2.4 Measuring Well-being

Just as subjective well-being can be divided into two main categories of hedonism and eudaimonia, so can measuring subjectively experienced well-being. To start with, subjective well-being is measured as an assessment of both the affective and the cognitive components of well-being. The affective component entails assessing positive affects or emotions against negative ones (also called the experiential aspects of well-being); and the cognitive component involves assessing the satisfaction with life (also called the evaluative aspect of well-being) (Diener et al. 1985; Pavot and Diener 1993; Diener 2009; Tinkler and Hicks 2011).

The affective components of subjective well-being relate to self-reported feelings or moods experienced by the individual during an activity, and representing feelings experienced over a short-term period. While the cognitive aspect relates to a longer time-frame. Schimmack (2008) observed that an individual's evaluation of his/her subjective well-being is related to "domain-specific satisfaction", which means satisfaction with family life, satisfaction with work life, and satisfaction with leisure pursuits and/or activities amongst other things. The eudaimonic approach of measuring well-being, otherwise referred to as the psychological approach sees well-being as entailing more than just experiential or evaluative measures, but also including means of capturing autonomy, control, competence, engagement, a sense of meaning, purpose and achievement, and good personal relationships. In essence, the eudaimonic approach measures conditions for living the best version of one's life (also known as flourishing) (Ryan and Deci 2001; Deci and Ryan 2006; Tinkler and Hicks 2011).

In practice however, two main methods are employed for measurement of well-being. Real Time Measures and Retrospective Measures. All the scales of measurement used in well-being research can be categorised under these broad headings. Real Time measures asks people to report on feelings they are experiencing during the course of an event (on-line) or what they are experiencing as the event is played back to them (retrospectively) (Larsen and Fredrickson 1999). This is also called the Experience Sampling Method (ESM) or the Ecological Momentary Assessment (EMA). Participants are prompted frequently and at random times for immediate and current feelings they are experiencing in their immediate surrounding (Stone et al. 1999; Stone and Mackie 2014; Friman et al. 2017a). Retrospective measures on the other hand asks people to reflect on and report a previously experienced activity over a specific period. The day reconstruction method (DRM) is the most commonly used version of retrospective measurement in well-being (Kahneman et al. 2004; Lancée et al. 2017). Retrospective measures of well-being are the most common method of measurement and most measurement scales are based on this process.

Real-time measures have the advantage of avoiding distortion and delay associated with the role of memory and interpretation the retrospective measures bring. However, due to the associated costs involved, it is more expensive, difficult to implement on any scale, and burdens the individual. This associated costs are mostly related to the money costs of implementing the measure in research, and time cost on the user – and these are critical considerations necessary for subjective well-being studies (Larsen and Fredrickson 1999; Kahneman et al. 2004; Krueger and Schkade 2008).

Some of the commonly used scales in subjective well-being studies are discussed below:

i. **Positive and Negative Affect Scale (PANAS)** – This scale was first proposed by Watson and his colleagues in 1988. It proposed to the interviewee to recall how they felt over the course of the last few days or week and presented them with 10 descriptors each for both positive and negative emotions, resulting in a 20-item scale. The respondents proceed to rate these emotions on a 5-point scale ranging from 'very slightly or not at all' to 'extremely' (Watson et al. 1988). This scale has become one of the most popular scales for well-being measures demonstrating strong evidence of validity and internal consistency (Crawford and Henry 2004).

ii. **Scale of Positive and Negative Experience (SPANE)** – This scale was developed by Ed Diener and his colleagues as an alternative to the PANAS in 2010. It proposes that the individual reports to which extent they had experienced certain feelings over the last four weeks, presents them with a scale of six items each for positive and negative feelings, which are then rated on a 5-point scale (Diener et al. 2010). One advantage of the SPANE over the PANAS is that it addresses the major criticism of the latter – which was not assessing both the positive and negative feelings associated with well-being. Another advantage is the time for recall was much shorter which gave the individual more chances of recalling a more accurate experience than the PANAS.

iii. **The Satisfaction with Life Scale (SWLS)** – This scale is used to measure overall life satisfaction commonly referred to as well-being in research. It was developed by Ed Diener and his colleagues in 1985. The scale presents five statements that rate the extent to which individuals agreed with them on a 7-point scale ranging from 'strongly disagree' to 'strongly agree' (Diener et al. 1985). This scale is quite common with well-being research. Diener et al. (1999) observed that this scale demonstrates strong reliability and viability.

iv. **The Personal Well-being Index (PWI)** – This was developed by an Australian research group in 2006 and was used to measure overall satisfaction with life. Individuals were asked to report their level of satisfaction under seven headings of quality of life measures sourced from a theoretical review of literature assessed on a 10-point scale (IWG 2006).

v. **The Meaning in Life Questionnaire (MLQ**) – Developed by Michael Steger and his colleagues in 2006, the MLQ is used to measure respondents' ratings for meaning and purpose in life. It consisted of 5 items rated on a 7-point scale with answers ranging from 'absolutely untrue' to 'absolutely true' (Steger et al. 2006).

vi. **Psychological Well-Being Scale (PWBS)** – This scale was originally developed by Carol Ryff in 1989. Along with the Personal Expressive Activities Questionnaire – Standard (PEAQ-S), the PWBS are popular measures for eudaimonia and psychological well-being. The scale measures the six categories of psychological well-being (eudaimonia) namely self-acceptance, personal growth, relatedness and positive relationship with others, autonomy, environmental mastery, and purpose in life. The six factor scale consisted of 32 items each (16 positive and 16 negative), although this was later reduced to 20 items, which was rated on a 6-point scale ranging from 'strongly agree' to 'strongly disagree' (Ryff 2014).

vii. **Personal Expressive Activities Questionnaire (PEAQ)** – This scale was created by Alan Waterman in 1993 to measure both hedonism and eudaimonic well-being. Six items each were used to assess both categories of well-being measured on a 2-point response scale labelled 'strongly agree' and 'strongly disagree' (Waterman 1993). As stated earlier, variations of the PWBS and the PEAQ are the most used scales for measuring eudaimonia. One advantage the PEAQ has over the PWBS is that while the latter incorporates a 6-factor scale to form a rather long set of variables, the former is less ambiguous and easily administered.

viii. **The Beliefs about Well-being Scale (BWBS**) – This scale was developed by Ethan McMahan and David Estes in 2011 as a tool that incorporates the two perspectives of well-being to form a much more rounded scale useful in measuring 'lay conceptions' of well-being. These lay conceptions of well-being are particular to the individual, complex and made up of various beliefs that form the basis of the lay population's perception of well-being (McMahan and Estes 2011b). Based on previous empirical and theoretical works on hedonistic and eudaimonic well-being, fifty items were initially identified to be used in the scale. After evaluating for specificity, clarity and non-repetition, the 50-item scale was condensed to a 30-item scale. Following further tests and analysis, the 50-item scale was reduced to 16 items incorporating both dimensions of hedonism and eudaimonia. The final version of the BWBS includes 16 items rated on a 7-point scale ranging from 'strongly disagree' to 'strongly agree' with properties shown to demonstrate strong reliability and validity when compared with other available well-being scales (McMahan and Estes 2011b).

2.2.5 Issues with Measuring Well-being

The problems besetting subjective well-being measurements identified from literature can be broadly categorised into two – time and context. It has been noted that, these problems arise from the assumption that (a) every individual can describe their emotions and feelings accurately and freely; (b) every individual can easily sum up their daily activities to infer a generalised conclusion; and (c) these generalised conclusions remain fairly stable over a long period (Sirgy 2012). These issues are discussed succinctly below:

i. **Time** – As Larsen and Fredrickson (1999) noted, feelings are often easier to quantify as they occur but they may prove more difficult expressing them retrospectively. This was first described by Schwarz and his colleague when they opined that affective experiences that have greater frequency or have more recently occurred are easily recalled and they create a memory bias when individuals report their well-being (Schwarz and Strack 1991). Fredrickson and Kahneman (1993) also observed a similar phenomenon which they termed the 'peak-end' rule often associated with retrospective methods. They noticed that the respondents' reports were skewed and based on the moments they had experienced the most intense and final emotions being measured. A remedy for this issue is by isolating the targeted emotion / event and measuring this emotion / event in real time, or immediately after its occurrence (Larsen and Fredrickson 1999). Another problem which is associated with time is that most well-being measures do not give enough time duration to capture the emotions or concept tested (Diener et al. 2010) resulting in partially reported data (at best). However, this can be effectively combated by measuring in real time (such as the Experience Sampling Method) or incorporating the relevant measurement scale(s) (Diener et al. 2010; Bhullar et al. 2013).

ii. **Context** – This has been the most critical issue against well-being measurements. Subjective well-being questions are very much susceptible to ambient and transient moods, and other environmentally induced human factors (Larsen and Fredrickson 1999; Krueger and Schkade 2008). Eid and Diener (2004) observed that between 4% and 25% of variance in various short term and long-term feelings measurements were affected by 'situation-specific' factors. Studies have confirmed that factors such as the respondents' current mood, the environment or location of the measurement, past events, and future expectations may influence the respondents' judgement and affect well-being reports (Larsen and Fredrickson 1999; Van Rooy 2006; Hennessy 2008; Diener 2009). Schwarz and Strack (1991) also observed that respondents that had

previously experienced negative events or trauma may report an event more positively than those who have not. This is because they subconsciously compare the current event to their previous traumatic experience and report their well-being more positively. Furthermore, Schimmack and Oishi (2005) also noted that the order to which subjective well-being questions are arranged in a questionnaire to a certain degree influences their responses.

Asides from this, when rating questionnaire well-being questions on Likert-type scales, respondents tend to view the midpoint of these scales as averages which they use as reference points and rate themselves accordingly (Schwarz and Strack 1991). Furthermore, questions that appear to test the same topic area tend to receive the same responses. As a result, the authors advised researchers to carefully structure their questionnaires so as to get the appropriate answers from their respondents (Schwarz and Strack 1991). One other thing worth mentioning is that respondents often report higher ratings for subjective well-being during a face-to-face interview than any other form of data collection (Diener 2009). This is because most times respondents do not want to look bad in front of their interviewer so they inflate their well-being to improve their social desirability (Schwarz and Strack 1991).

Most of the issues associated with well-being measurements can be resolved using real time measurement techniques and appropriate measurement scales. Krueger and Schkade (2008) advocated for a 'test-retest' reliability measure for subjective well-being studies in addition to these measures to further improve the reliability of well-being measures in research – an advice this research took and is discussed in the analysis chapter.

2.2.6 Subjective Well-being and Public Policy

Over the course of this discussion, the impact of subjective well-being on public policy formulation has been highlighted. There was a time when economic wealth was all the measure governments around the world needed to access growth and satisfaction among her populace. However, this has come to change recently. Even economists have sided with philosophers to advocate for the use of subjective well-being and quality of life indicators as measures of performance. This is because in the end, the goal of any public policy is to improve the standard of living and enhance the quality of life of the population. Diener and Seligman (2004) further gave credence to this movement when they discovered that subjective well-being has decreased over the last few years while economic wealth has soared in developed countries. However, if more emphasis is placed on subjective well-being and quality

of life over economic wealth, it is believed that this would result in an improvement to the general well-being of the population. Diener et al. (2009) aptly noted that, "…if a society begins measuring well-being…it is likely that published measures of well-being would lead to more attempts to increase it, and of course, better information on whether these attempts are successful." (p.66).

According to De Vos et al. (2013), well-being can be viewed as a personalised and subjectively experienced way of living, which is influenced by behaviours and objective circumstances (e.g. objective health, social and physical environment). As a result of this, the well-being of an individual can be enhanced by changes in those behaviours and circumstances which can be brought about by informed policies and decision-making. Due to this, studies have posited that changes in well-being should be increasingly seen as a more meaningful way of evaluating development, social progress and government policy than other changes focussing on wealth, such as economic output or GDP (Veenhoven 2002; Diener et al. 2009).

This has led to subjective well-being being the popular choice studied by academics in recent publications and a renewed interest in well-being in the world of policymaking. The UK for instance has seen a rise in legislations and regulations promoting well-being. The Localism Act 2011 – which amongst other things promotes housing allocation and community empowerment within local areas – and the more recent Social Action, Responsibility and Heroism Act 2015 – that protects the rights of individuals, organisations and communities regarding compensation claims – comes to mind (DCLG 2011). In Wales, the Social Services and Well-being (Wales) Act 2014 and The Well-being of Future Generations (Wales) Act 2015, informed by the 'Wales We Want' consultation are examples of recent well-being-oriented policies (SDB 2015). These policies require public bodies in Wales to consider the long-term impact of their decisions, to work better with people and their communities, and to prevent persistent problems such as poverty, health inequalities and climate change within the local areas.

This is not to say there has not been any criticisms regarding policy focus on subjective well-being and quality of life. Eckersley (2009) opined that subjective well-being measures present an exaggerated positive view of developed countries and/or western cultures to the rest of the world. This is because happiness and maximization of pleasure is a cultural norm that is greatly encouraged in western cultures whereas it is somewhat conservative in the cultural norm and value elsewhere. Furthermore, there has been arguments in the academic sphere that current progress in subjective well-being is skewed towards individual based well-being research while societal based well-being research is abandoned (Sirgy 2012). Although it can

be argued that since the individual/household is the basic unit of the society, attention to this aspect should have a generalised effect on the society in the long run. Sirgy (2012) however suggested that researchers should embrace emerging themes and focus on indices not only unique to the individual but also to the society at large (such as travel and transportation, social cohesion, environmental quality, etc.).

The previous sections have been able to provide a review for the better understanding of the literature surrounding well-being, and its related concepts. The aim here is to provide a compendium that discusses well-being in a way not previously seen in literature while tackling the inadequacies within the current works of knowledge.

2.3 Travel and Well-being

It is important to note here that studies on well-being (especially in relation to travel) have always focused on hedonism. Little attention has been given to the eudaimonic view of well-being and travel behaviour. This might be because of the complexity in relating the concept of eudaimonia to travel behaviour. From a transport perspective, Tyler (2014) defined well-being as, 'the achievement of reasonable health, economic stability, freedom to be able to choose the activities one wishes to pursue, access to sufficient resources, including water and food, availability of educational opportunities, and a life in which social justice prevails' (p. 536). He observed that transport is needed to access or provide many of these processes and it is through the participation in these processes, that people derive their well-being. He proposed four components of accessibility, mobility, movement and transport, all working together in a set he termed, 'the accessibility system'. Accessibility defines whether a city can provide a satisfactory sense of well-being. Mobility is the linkage between people and the activities, goods and services they require, as such, accessibility is the availability of mobility. Since it requires the physical movement of people, goods and services to each other, it is necessary to maximize mobility and minimize movement (and reduce the carbon footprints of the movement process). Finally, the transport system delivers movement. In sum, the transport system needs to be able to provide as much movement as possible in order to deliver the required mobility in a way that minimises the negative impacts of movements, so that activities, goods and services are accessible and well-being is achieved for the whole (Tyler 2014).

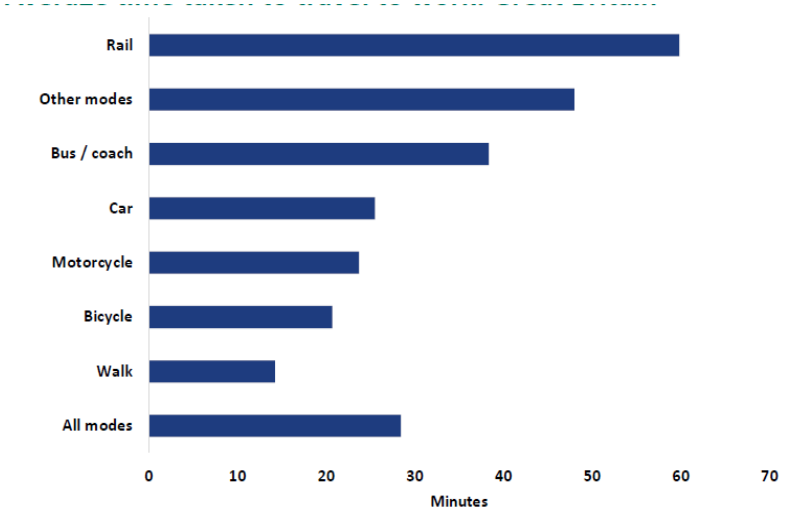
As mentioned earlier, few number studies have linked commuting with the physical, mental and overall well-being of the individual. Most studies on commuting and well-being have focused on the effects of traffic congestion on well-being. Some have adopted changes in commuting modes or type of commute to address the topic (Abou-Zeid 2009; Abou-Zeid et al.

2012). A few others have also tried to explain the impacts commuting has on well-being by considering the journey times (when) and the average journey distance (Stutzer and Frey 2008; Olsson et al. 2013; Lancée et al. 2017). In all, it is evident that commuting has an impact on the well-being of the individual and plays a pivotal role in their daily activities (Roberts et al. 2011; De Vos et al. 2013).

In their daily lives, people want the journey between home and work to be as comfortable as possible. Therefore, a commute associated with longer distance and time has a higher level of negative behavioural and psychological outcomes and ultimately results in a negative impact on well-being (Koslowsky et al. 1996; Abou-Zeid et al. 2012). In other words, the longer the time and distance travelled by a person the more likely they are prone to negative attitudes thereafter (at the workplace, home, etc.). This view is reiterated by Nobel laureate Daniel Kahneman in his work on subjective well-being with Alan Krueger. They found out that long commutes to workplace especially in the mornings, are the least favourite activities for most people in their daily lives which impact negatively on their moods and activities at the workplace (Kahneman and Krueger 2006).

As much as people dislike long commutes, the question now arises on the appropriate duration the average commuter journey should take. In the UK, recent transport statistics show that it takes the commuter an average of 29 minutes to travel (across all modes of transportation) with rail commuters experiencing the highest average commute time of 60 minutes and walking commuters the shortest commute time of 12 minutes (see Figure 2.2) (ONS 2014). In his survey of the heart rate and blood pressure of 125 commuters, stress expert Dr David Lewis suggested that average commute time is between 45-60 minutes which translates to at least a working day a week for most people (Lewis 2004). Generally, the optimum travel time according to a study is between 20 minutes and 25 minutes across all modes as active commuters with less travel time wish for more, while auto and public transit commuters with more travel time wish for less (Páez and Whalen 2010). All these journey times are average figures for European cities and they are moderate if compared to the account from Asian mega-cities of an average of 120 minutes per day (Jones 2002).

Figure 2.2: Average Commuting Time in the UK



Source: Office of National Statistics – ONS (2014)

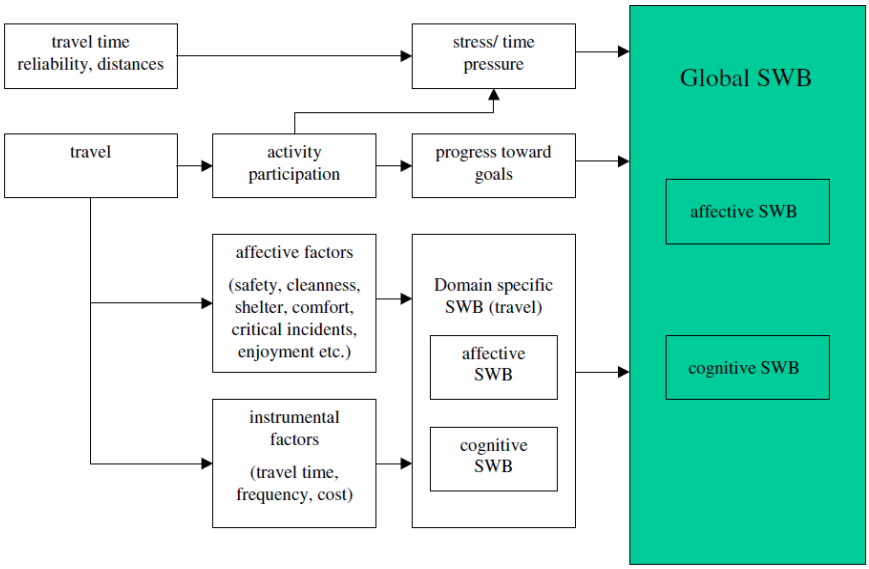
In terms of financial costs, the Department for Transport discovered that the average UK household spend 13.1% of their income on commuting and transportation needs in 2012 alone (ONS 2014). Although these costs represent a decrease of 1.4% from the 2000/2001 figures, it however represents substantial deductions which has a significant impact on the average household income.

Considering these impacts commuting has on the quality of life, the most rational solution would be to reduce the average distance/time travel or at the very least make journey times as comfortable as it can be for commuters. This might explain why individuals find means of reducing their commute distance and time to work through various measures such as working flexible hours and telecommuting, to mention a few, and utilizing this extra time with their families and increasing their sense of physical and mental well-being (Santhosh 2015).

2.3.1 Travel Behaviour (in the context of Well-being)

Researchers have long sought to understand what motivates people to carry out their daily activities and how they use the available transport resources to achieve this. As working, living, shopping and recreating are spatially separated activities connected by circulation, people have to travel to participate in these activities in order to achieve social and economic self-fulfillment (Van Acker and Witlox 2007). Ettema et al. (2010) observed that travel affects subjective well-being in two different ways, stimulating both the positive and negative affects of well-being and the cognitive aspects to determine overall travel satisfaction (see Figure 2.3).

Figure 2.3: Effects of Travel on Subjective Well-being



Source: Ettema et al. (2010, p.728)

Summarising the relationship between travel and well-being, De Vos et al. (2013) identified five ways travel behaviour affects subjective well-being. These are briefly explained below:

i. Positive or negative feelings can be experienced by individuals when undertaking daily travel which tends to affect the individual's needs satisfaction and goal realisation all of which affects the individual's well-being (Abou-Zeid 2009; Ettema et al. 2010; Abou-Zeid et al. 2012). Furthermore, trips involving mode transfers are deemed as complicated thereby resulting in increased levels of stress experienced which in turn affects the overall level of trip satisfaction negatively (Wener and Evans 2011).

ii. The inability to participate in activities due to a form of transport disadvantage may adversely lower the individual's sense of well-being and trigger feelings of social exclusion (Currie et al. 2010; Delbosc and Currie 2011). Experiential spill-over effects have been known to arise also. Studies have been able to show that a long commute to the workplace especially in the mornings, is the least favourite activity for most people in their daily lives, and this impacts negatively on their moods and activities at the workplace (Abou-Zeid et al. 2012).

iii. Activities otherwise undertaken in stationary locations such as reading a book, typing on a laptop, etc., can affect the feelings experienced during travel and positively impact the evaluation of the total journey (Ettema et al. 2012).

iv. The capacity of an individual to be mobile can affect their well-being. Individuals with greater mobility have been known to exude feelings of freedom, competence and belonging as well as confidence in their abilities to achieve set goals (Nordbakke and Schwanen 2014b,a). De Vos et al. (2013) further observed that the mere knowledge of and/or skill required to use transport resources as well as their availability could generate feelings that improves the well-being of the individual.

v. Finally, journeys undertaken to increase satisfaction, joy or contentment as against a particular destination such as recreational walking and cycling, otherwise known as undirected travel, can contribute to improved ratings for subjective well-being in an individual (Mokhtarian and Salomon 2001). Furthermore, evidence from research has shown that active commuting activities such as cycling and walking, constitute a form of physical exercise which cause the release of "feel good" hormones that are associated with exercise thereby improving the individual's mood, reducing negative emotions like anxiety and depression, improving cognitive performance and generally improving physical and mental well-being (Penedo and Dahn 2005; Guell et al. 2012; Humphreys et al. 2013).

2.3.2 Factors Influencing Travel Behaviour (in the context of Well-being)

Several factors influence (and/or determine) travel behaviour directly or indirectly. These factors have also been found to relate to how people perceive their satisfaction with travel and their well-being. The following presents a lucid summary of the factors:

i. **Urban Form** – To start with, urban form can play a significant part in influencing travel patterns and behaviours. Evidence shows that lower density, single use land zoning produces longer travel journeys resulting in a greater reliance on the use of the car as the principal means of transport (Mouratidis et al. 2019). However, higher density land use with mixed zoning and greater access to sustainable transport modes is likely to promote more sustainable travel behaviours and active travel (Cervero 2002; Giuliano and Narayan 2003; Naess 2003; Naess and Jensen 2004). Furthermore, neighbourhood satisfaction, personal relationships satisfaction, and perceived physical health are higher in compact urban areas, while anxiety is lower in sprawled suburbs, and overall levels of SWB are similar for the two types of urban form (Feng et al. 2018)

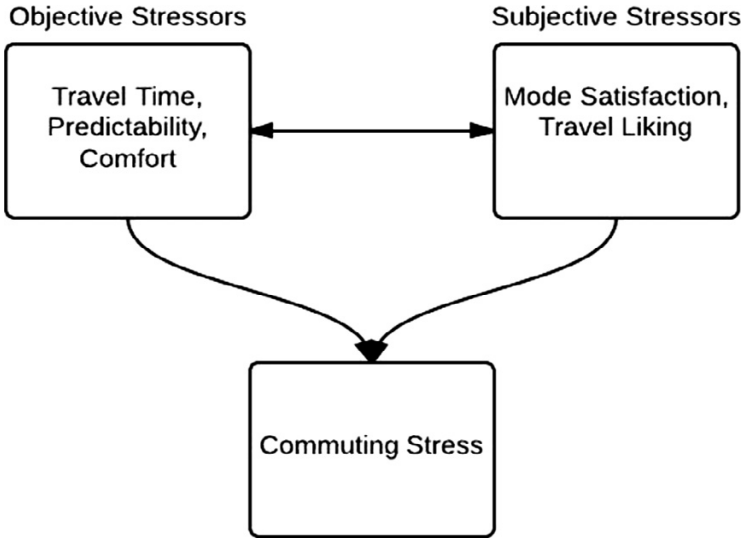
ii. **Socio-demographic characteristics** – Socio-demographic factors have also been found to influence travel behaviour. Evidence suggests that the socio-demographic variables that influence travel behaviour include age, income, car ownership, household composition and gender (Dieleman et al. 2002; Giuliano and Narayan 2003; Polk 2003,2004; Best and Lanzendorf 2005; Wu et al. 2019). However, a general theme noticed from these studies was that household composition and gender (most especially) are the two most crucial socio-demographic determinant of travel behaviour.

iii. **Commuting stress** – In the context of well-being, commuting stress, travel satisfaction and overall life satisfaction have all been identified as crucial to the understanding of travel modal choice and travel behaviour (Legrain et al. 2015). These are briefly discussed below but with substantial focus on commuting stress because it connects travel satisfaction with overall life satisfaction (well-being in this case).

The daily commute of an individual has almost synonymously been associated with stress. This is because commuting has been linked to physically and mentally experienced stress on numerous occasions (Novaco and Gonzalez 2009). Not only is commuting the least enjoyable form of travelling one can embark on (Morris and Guerra 2015a), but it is also the least enjoyable activity of an individual's best enjoyed activities (Kahneman and Krueger 2006). Furthermore, commuting stress has been consistently identified as a major determinant of health problems that undermines the enjoyment of good quality of life and reduces the overall life satisfaction of the individual. It has been linked with increased rates of heart attacks and obesity (Hoehner et al. 2012), poor health, exhaustion and feelings of depression (Gee and Takeuchi 2004), absentee-ism, low employee morale, job dissatisfaction and poor job performance (Koslowsky and Krausz 1993; Koslowsky et al. 1995; Koslowsky et al. 1996). Commuting stress is caused by 'travel impedance' associated with a particular mode of transportation. This was first described by Raymond Novaco and his colleagues in 1979. As the name suggests, a travel impedance may be defined as any condition, activity or factor that obstructs with the proper enjoyment of travelling such as congestion or delay (Novaco et al. 1979). Explaining further, Novaco et al. (1990) observed that the level of impedance experienced corresponds to the travel time or travel distance. As such, an individual may observe a lower travel impedance when travelling fast over a short distance and vice versa. Travel impedance can be further subdivided into objective impedance and subjective impedance. As Legrain et al. (2015) pointed out, commuting stress is a function of the interaction of the two

subdivisions of travel impedance with objective impedance including stressors such as time, control and comfort, and subjective impedance including such stressors as feelings, desires and satisfaction (see Figure 2.4).

Figure 2.4: Dimensions of Commuting Stress



Source: Legrain et al. (2015, p.142)

In regards to conditions that may help reduce commuting stress, it has been suggested that: (i) increasing the perceived level of control might help as the degree of personal control over the course of a journey determines how stressful the journey is perceived (Novaco et al. 1990; Wener et al. 2005); and (ii) increasing the comfortability levels as this also greatly determines the experience of impedance during the course of a journey (Koslowsky et al. 1995; Novaco and Gonzalez 2009).

iv. **Travel Mode** – Regarding travel modes, several studies have considered commuting stress across all the major modes of transportation. Due to factors such as feelings of power, control, convenience and privacy amongst others, auto-commuting has been shown to elicit more positive emotions than commuting via public transit (Mokhtarian and Salomon 2001; Hiscock et al. 2002; Ettema et al. 2011; Abou-Zeid et al. 2012; Olsson et al. 2013; Morris and Guerra 2015b). Although auto-commuters are happier than public transit commuters, driving is considered the most stressful (even if public transit commuters experienced the most stressors – waiting time, dissatisfaction with bus/train times – of all) as they have to factor in more time to accommodate for loss time due to congestion and other factors in their journey (Wener and Evans 2011; Legrain et al. 2015). Active modes of travelling (cycling and walking) have been associated with greater feelings of positive emotions and lower feelings of commuting

stress, negative emotions and dissatisfaction (Abou-Zeid 2009; Humphreys et al. 2013; Martin et al. 2014; St-Louis et al. 2014).

v. **Travel Time** – In terms of travel time, evidence suggests that the well-being of commuters is significantly affected by longer commutes through travel impedance. In other words, commuters who travel quickly through shorter distances experience the least impedance and the least commuting stress (Novaco and Gonzalez 2009). Similarly, the longer a commute the lower the overall life satisfaction/well-being (across all modes of transport), and the higher the rating for commute dissatisfaction because of increase in stress, pain, sadness and fatigue (Ory and Mokhtarian 2005; Stutzer and Frey 2008; Morris and Guerra 2015a).

vi. **Travel Costs** – travel costs have also been identified to influence travel behaviour. Studies have shown that almost everyone considers costs before choosing the mode of travel, and women are less car dependent and more likely to switch to public transit to replace car journeys and save costs (Hensher and King 2001; Simićević et al. 2016).

vii. **Lifestyle Factors** – Finally, lifestyle factors (or psycho-social factors) have been found to also influence travel behaviour. This includes people opting to reside in 'new urbanist' areas to enable them to indulge in travel behaviours that would normally be seen as unusual in a conventional suburban neighbourhood such as active travel and public transit (Cao et al. 2006), or the perception of autonomy, protection, prestige and power synonymous to 'street cred' (especially among males) that car ownership brings (Hiscock et al. 2002). Whatever the case may be, these lifestyle factors also play in role in determining travel behaviour.

Although commuting has been termed and viewed as strenuous, some researchers believe it could be a pleasant activity and have a positive effect of overall well-being. White and Dolan (2009) opined that commuting, which is at best described as having an average enjoyment factor, is better enjoyed than unpleasant activities such as chores or work, and lesser enjoyed than pleasant activities such as socializing. Mokhtarian and Salomon (2001) observed that travel (especially undirected travel) can increase an individual's general well-being by increasing feelings of satisfaction. Furthermore, commuting can help relax the mind and body especially when done in a tranquil environment helping one escape both work and home related stresses or aiding the transitioning between the two domains, e.g., transitioning from work to home and vice versa (Ory and Mokhtarian 2005; Haider et al. 2013). Finally, a recent Swedish study discovered that people are rather happy (and contented) with their commute

(Olsson et al. 2013). However, this may simply be because of the 'hedonic treadmill' where people have adapted to the stress of their commutes and have developed a coping mechanism in response to it (Campbell et al. 1976; Diener et al. 2006).

In sum, the interplay of elongated commute time and distance, and commute situation results in commuter stress, which has an important significance commute satisfaction and ultimately on physical and psychological well-being. This is important because recent researches have revealed that the cognitive processes that are involved in appraisal, information processing and attention, which are crucial for effective coping mechanism, may be detrimentally affected by commuting stress (Matthews 2002).

2.4 Measuring Travel Behaviour (in the context of Well-being)

Researchers in the field have gone ahead to adapt some of the well-being scales in the context of transportation to measure latent variables. Only two of these adapted scales have been used extensively in travel and well-being research. These scales are discussed below:

i. **The Satisfaction with Travel Scale (STS)** – This scale was first described by Dick Ettema and his colleagues in 2011 and is based on the Swedish Core Affect Scale (SCAS) by Vastfjall and colleagues developed in 2002 (Ettema et al. 2011). The STS is based on methods developed to measure subjective well-being (affective and cognitive aspects) but specific to a domain satisfaction – travel satisfaction in this case. It is a domain specific version of the term. The scale has gone on to be widely used to measure how people perceive their travel in recent times. Delving further into what the STS scale entails, the items that measure the affective components can be divided into two states namely activation (ranging from activated to deactivated) and valence (ranging from positive to negative) while the cognitive component is measured through a statements about the journey (Ettema et al. 2011). Just like in the SCAS, the STS uses three adjectival pairs (enthusiastic/bored, engaged/fed up, and alert/tired; and calm/stress, confident/worried, and relaxed/hurried) for measuring two sets of specific combinations of valence and activation (positive activation/negative deactivation and positive deactivation/negative activation) respectively. These constructed nine item scale (include three items for measuring the cognitive component of travel) measured on a 7-point adjective scale, ranging from -3 to 3 (De Vos et al. 2015).

ii. **The Satisfaction with Daily Travel Scale (SWDTS)** – This scale is based on the Satisfaction with Life Scale (SWLS) developed by Ed Diener and his colleagues. This

is a very minimalistic scale constructed in 2011 by Cecilia Bergstad and her colleagues, by transforming all the statements of the SWLS to travel-related ones (Bergstad et al. 2011). According to the authors, this scale was developed to measure respondents' satisfaction with daily travel without concentrating on any specific mode of travel. Five statements, ''I am completely satisfied with my daily travel''; ''My travel facilitates my daily life''; ''When I think of my daily travel the positive aspects outweigh the negative''; ''I do not want to change anything regarding my daily travel''; and ''My daily travel makes me feel good'' were rated on a 7-point Likert scale ranging from 'do not agree' to 'agree completely' (Bergstad et al. 2011).

These previous sections have been able to present a review of travel / commuting as it relates to well-being within the literature. Subsequent sections discuss the theoretical and conceptual underpinnings of the research.

2.5 Theoretical Framework

As previously explained, subjective well-being consists of three components; (i) the presence of positive feelings or emotions, (ii) the absence of negative feelings or emotions and (iii) the satisfaction with life or overall well-being (Diener 1984; Diener 2009). Generally, subjective well-being is measured as an evaluation of positive affects or emotions against negative ones – often referred to as the affective components – and an evaluation of a person's satisfaction with life otherwise referred to as the cognitive judgement of life satisfaction (Diener et al. 1985; Pavot and Diener 1993; Diener 2009).

The affective components of subjective well-being have come to relate to self reported feelings or moods experienced by the individual during the course of an activity, and also representing feelings experienced over a short-term period, while the cognitive aspect relates to a longer time-frame. Schimmack (2008) observed that an individual's evaluation of his/her subjective well-being is related to what he termed, "domain-specific satisfaction", which includes satifaction with family life and work life amongst other things. Ettema et al. (2010) identified travel as another domain-specific satisfaction which may affect subjective well-being. However, what is not clear here is whether people who elicit a higher rating for subjective well-being evaluate other domain-specific satisfaction positively, or subjective well-being is influenced by domain-specific satisfaction (Schimmack 2008).

2.5.1 Travel Satisfaction and Subjective Well-being

"So how does travel contribute to subjective well-being?"

It is assumed that due to its ability to increase and enable activity participation – which is very important for people to achieve set goals – travel improves life satisfaction which in turn improves the level of subjective well-being (Abou-Zeid 2009; Ettema et al. 2010). However, studies have shown that the effects of travel on subjective well-being is not so straight forward. Just as subjective well-being incorporates both affective and cognitive components, so does travel satisfaction. The affective components of travel satisfaction relate to the mood and feelings experienced during the course of the journey such as anger, stress and tension amongst others, while the cognitive aspect is an evaluation of the general quality of the travel regardless of the travel mode used (Ettema et al. 2010; Friman et al. 2013). Russell (2003) reported that, the mood and feelings (affective components) experienced during a journey varies in two forms, a pleasantness-unpleasantness dimension called "valence" and an active-passive dimension called "activation". Friman et al. (2013) also demonstrated that these two aspects of travel satifaction (affective and cognitive components) can be correlated by using a confirmatory factor analysis to test their psychometric properties (i.e., the ability to measure moods and feelings), thus forming an overall construct for travel satisfaction. Based on these positive and negative feelings or emotions experienced during travel, the authors proposed two affective component of travel satisfaction ranging from PAND – positive activation (e.g enthusiastic) to negative deactivation (e.g bored) and from PDNA – positive deactivation (e.g calm) to negative activation (e.g stressed). These two form the basis for the scales adopted later in this study.

It is important to remember at this juncture that studies have observed that both the experience and perceived satisfaction of a journey can affect the activities conducted later on at the destination and how individuals might perceive such activities (Ettema et al. 2010; De Vos et al. 2013). A journey that is positively perceived might improve the subjective well-being of the individual and thus increase satisfaction with activities conducted at the destination and the mood of the individual (and vice versa). Consequently, there is the probability that individuals might evaluate their overall well-being more positively because of their satisfaction with travel (and vice versa). Thus this effect has come to be termed spill-over effects and will be discussed later in the chapter.

This research conducts an analysis into the potential spill-over effects of commuting vis-à-vis travel satisfaction on individual's mood at the destination and also look at the relationship

across commuting, travel satisfaction, subjective well-being and overall well-being (life satisfaction). But first, a brief summary of some relevant empirical studies investigating commuting behaviour vis-à-vis commuting time, mode, distance, travel satisfaction, subjective and overall well-being and the methods adopted in these studies will be discussed so as to provide a context for the reasoning behind the methodology adopted in this research.

2.5.2 Investigating commuting behaviour, travel satisfaction, and well-being

There have been several studies into commuting and well-being as the previous sections have shown. However, some empirical studies have been identified and the method they adopted is discussed below. These studies have broadly been categorised into two groups; studies around devising a new measurement tool, and studies on the impacts and relationships that exist among various concepts around commuting and well-being. Further details about these studies can be found in appendix II of the appendix section.

2.5.2.1 Devising a measurement tool

Abou-Zeid (2009) developed methods for the measurement of activity and travel well-being with the overall goal of contributing to the measurement and modelling efforts especially of subjective well-being as it relates to well-being. Two well-being concepts were discussed in her work, namely activity well-being and travel well-being. Activity well-being was investigated both empirically and theoretically. The empirical analysis involved the development of models of activity participation and well-being using data from a web-based cross-sectional survey of a sample of commuters while the theoretical analysis consisted of the development of a framework and measures for the incorporation of well-being within the activity-based models of travel demand undertaken by the author. As regards travel well-being, the analysis was done in the context of the commute to work. Using the web-based cross-sectional survey, structural equations model was developed to model the causes and correlates of commute satisfaction.

Building upon the work of Maya Abou-Zeid, Ettema et al. (2011) developed and tested a measure of travel-related subjective well-being (SWB), using the nine item self-report satisfaction with travel scale (STS). The aim was to investigate how mood and satisfaction are influenced by the STS. Travel satisfaction was measured by the Satisfaction with Travel Scale (STS), experienced mood was measured using the Swedish Core Affect Scale (SCAS) while subjective well-being was measured by using the Satisfaction with Life Scale (SWLS). In the analysis, all the items used for measurement were summated and averaged before a test for

reliability was undertaken for each using the Cronbach's alpha. Afterwards, the STS and mood sub scales were correlated, and tests of significance were performed by means of an overall analysis of variance which was followed by separate t-tests on each measure being used.

2.5.2.2 Studying impacts and the interconnectivity of concepts

I. Commuting, Travel Satisfaction and Well-being

De Vos (2017) studied the impact of short-term and long-term experiences on travel satisfaction, activity satisfaction and life satisfaction and how these three concepts are connected. To measure people's travel satisfaction, the Satisfaction with Travel Scale (STS) was used. For measuring activity satisfaction, a similar scale to the STS was applied called the Satisfaction with Activity Scale (SAS) and life satisfaction was measured using the Satisfaction With Life Scale (SWLS). The author then used a structural equation modelling approach to analyse how the three concepts of travel satisfaction, activity satisfaction and life satisfaction are correlated to each other.

In the same theme of studying the impact of travel satisfaction on well-being, Friman et al. (2017b) investigated the impact of work commutes to the moods experienced by individuals. Measures adopted in this study included socio-demographics, a mood question measured at time T_0, T_1 and T_2 (before, after and sometime later respectively), travel satisfaction measured with the Satisfaction with Travel Scale (STS), questions on commute characteristics, and a question on non-travel mood influences. In analysing the data collected, all measures employed were run through a multiple regression analysis. Afterwards, two separate sets of regression analyses were conducted with the two measures of mood (valence and activation) immediately after the commute (at time T_1) as the dependent variables and commute characteristics as independent variables. Then another two separate sets of regression analyses were conducted with the two measures of mood (valence and activation) obtained at a later time T_2 at the workplace (a while after time T_1) as the dependent variables with commute characteristics also serving as independent variables. For both time T_1 and T_2, mood (valence and activation) at time T_0 along with some selected socio-demographic variables were adopted as control variables. Finally, three separate sets of regression analyses were conducted with the STS measures of satisfaction as dependent variables and commute characteristics as independent variables. The control variables for these sets of analyses were the mood (valence and activation) at time T_1 and selected socio-demographic variables.

In a another similar study to the ones mentioned above, Westman et al. (2013) tried to understand what children's reported mood was during travel and how these moods affected their perception of activities undertaken at the destinations of their travel. The data collected included reports of travel mode used, experience of every-day travel (measured via a simplified version of the satisfaction with travel scale), activities on arrival, and the experiences of activities (measured by a simplified version of the Swedish Core Affect Scale). The inferential statistics in this study were reported using the analysis of variance (ANOVA). For the experiences of every-day travel, two separate one-way ANOVA were performed with destination (home, other persons' home, school, leisure activities, and entertainment/private) as independent variable and degree of valence during travel as dependent variable in the first, and degree of activation during travel as dependent variable in the second. For the experiences of the journey to school, two one-way ANOVA were performed with travel mode (cycle, car, walking) as independent variable and activation during travel as dependent variable in the first, and activation on destination as dependent variable in the second. Also, a two-way ANOVA was performed with mode and gender as independent variables and activation during travel to school as dependent variable was performed to determine gender differences in the experience of the journey to school. To determine if there were any spill-over effects of travel mode on affective experiences during the school day, two separate sets of two-way ANOVAs (with mode and gender as independent variables and activation and valence for each set of ANOVAs during the school day as dependent variable) were conducted.

With regards to commute mode and travel satisfaction, in a study to investigate whether satisfaction with daily travel by car has a positive impact on subjective well-being (SWB), Bergstad et al. (2011) first assessed how much of the variance in satisfaction with daily travel using the Satisfaction with Travel Scale (STS) is accounted for by car access and use. Then they assessed how much of the variance in subjective well-being (concentrating on weekly mood, affective and cognitive SWB) is accounted for by the STS. Finally, the authors assessed whether the effect of the STS on subjective well-being is direct, mediated or both direct and mediated by satisfaction with the activities the respondents performed (they used a Satisfaction with Activities Scale to measure this) using a regression analysis.

Similarly, Legrain et al. (2015) employed the use of several ordered logit regression models in studying the relationship between commuting characteristics (including modal influence), travel satisfaction, subjective and objective stressors across three modes of transportation (walking, driving and public transport). In all models of the regression analysis performed, the reported stress was denoted as the dependent variable while the independent variables

included relevant variables relating to travel satisfaction, travel stress and subjective well-being all of which were obtained from a review of literature. The authors also factored in control variables (mostly socio-demographic variables) to accommodate for demographic differences and residential location choices.

Olsson et al. (2013) were able to show that the satisfaction with work commutes contributes to the individual's overall happiness by adopting a questionnaire approach consisting of questions about the work commute, overall happiness, and socio-demographics. Furthermore, the Satisfaction with Travel Survey (STS) was used to assess satisfaction with the commute to and from work while the Satisfaction with Life Scale (SWLS) was used to assess overall happiness. During the analysis of this data, a composite measure of satisfaction with the work commute was formed by averaging across all nine STS scales. Thereafter, correlation analyses were conducted between the composite measure of satisfaction and the primary travel mode for both commutes to and from work to indicate association. Furthermore, multiple linear regression analyses were used to determine the significance between overall happiness, commute time and commute modes, with SWLS and affect balance (from the STS) as dependent variables, separately for the commutes to work and from work.

For a complete description of these studies, please see appendix II in the appendix section included. The selected studies discussed above were some of the relevant studies that provided context and direction in setting up the methodology adopted in this study.

II. Commuting, Travel Satisfaction, Available Infrastructure and Well-being

Chng et al. (2016) in exploring the relationships between commute mode, neighbourhood public transport connectivity and subjective well-being used a rather straight-forward approach. They assessed how commute mode and neighbourhood public transport connectivity were associated with subjective well-being for all commuters and for public transport commuters separately. Then they assessed predictors for public transport usage exploring whether commuters residing in neighbourhoods with better connectivity were more likely to use public transport and whether using public transport in neighbourhoods with better connectivity was associated with greater well-being.

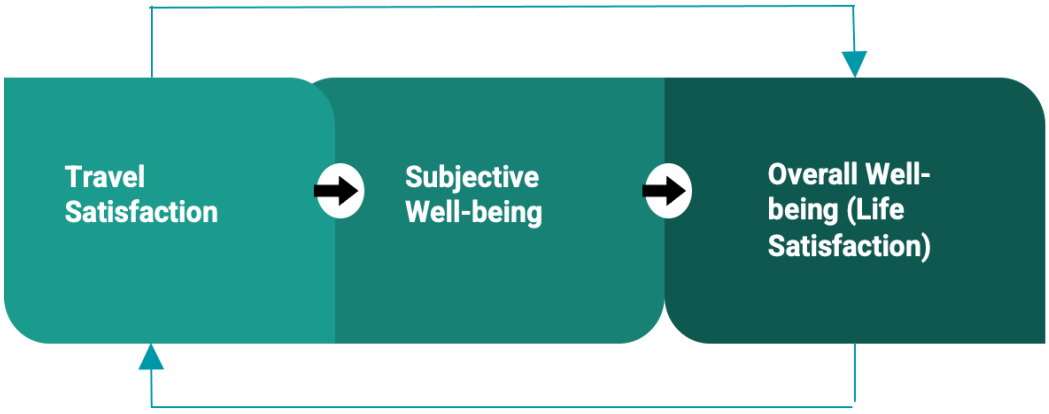
In their study to illustrate how the availability of built amenities, natural amenities, weather and attitudes toward travel explain actual and unserved travel demand and subsequently quality of life (i.e. well-being) Kolodinsky et al. (2013) employed three different structural equation models (SEM) to effectively model well-being and its influencing variables. The first SEM

predicted the probability of any form of unserved travel demand, the second SEM predicted the probability of making at least 1 trip, while the third SEM (using ordinary least squares regression techniques) predicted the relationship between well-being, community amenities, attitudinal statement regarding travel characteristics and the weather.

2.6 Conceptual Framework

Having understood some of the methods adopted by previous studies, an overview of the conceptual study framework is presented next. It is assumed that individuals can experience positive and negative feelings during the cause of their daily travel which will affect their moods / emotions and the evaluation of their journey. Also, activities undertaken during the course of an individual's daily travel (e.g listening to music, socialising with other passengers, etc.) can affect the feelings experiences during the journey, thus resulting in a relationship between travel satisfaction and overall well-being through the subjective experience of well-being (Ettema et al. 2010; Abou-Zeid et al. 2012; Ettema et al. 2012) (see figure 2.5). Furthermore, following from the spill-over effects of travel and travel satisfaction, a reverse relationship might ensue between travel satisfaction and overall well-being (life satisfaction). One in which the individual's perceived level of travel satisfaction might have an effect on their overall well-being (life satisfaction), and another where the overall well-being of the individual affects their perceived travel satisfaction (Diener 2000,2009). Figure 2.5 shows the relationship across travel satisfaction, subjective well-being and life satisfaction (overall well-being).

Figure 2.5: Relationship across travel satisfaction, subjective well-being and life satisfaction



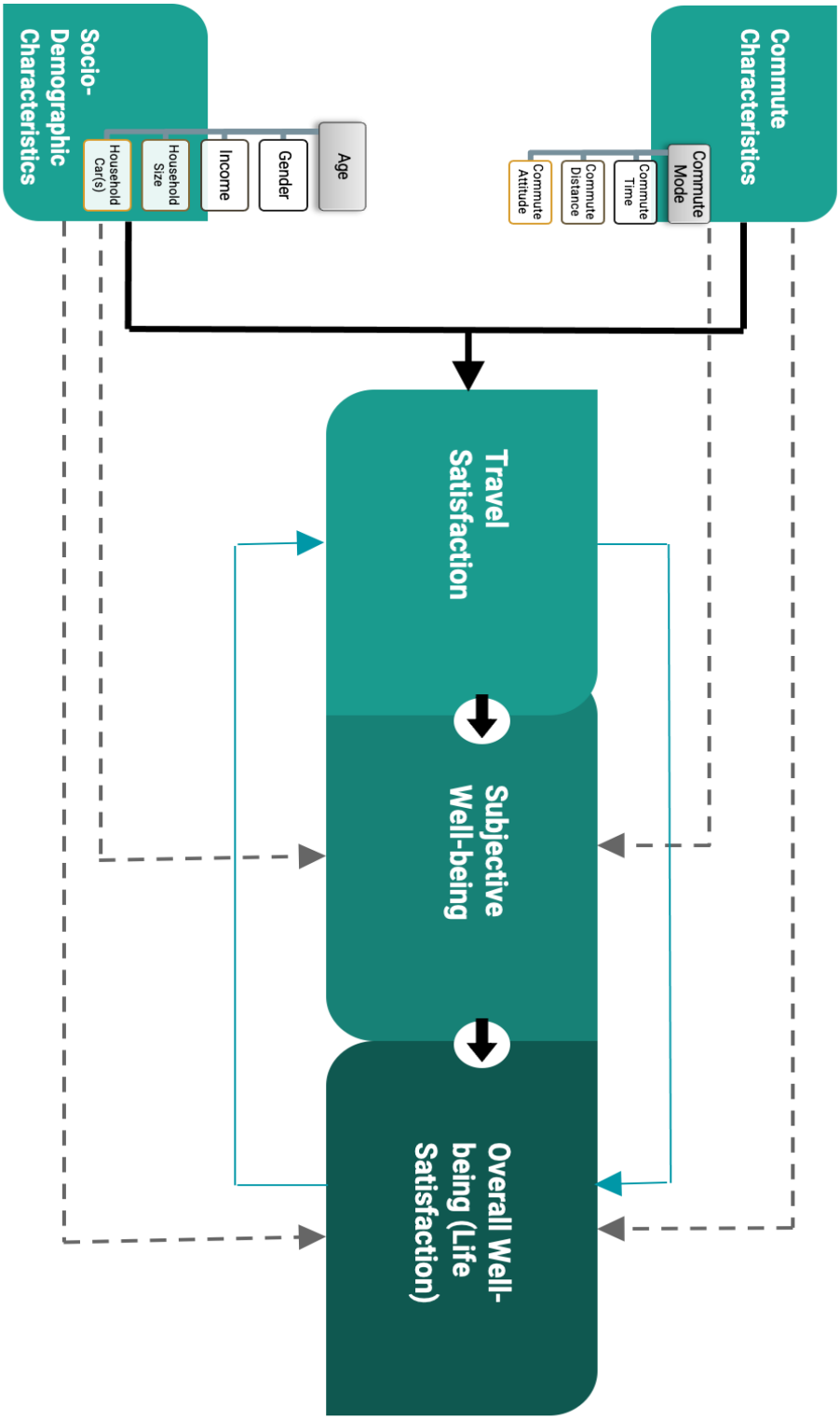
**Black arrows represent forward relationship; Blue line arrows represents forward and backward relationship suggesting an inter-relationship across all three.*

Source: Author from a review of literature

Regarding the relationship across commuting, travel satisfaction, subjective well-being and overall well-being (life satisfaction), previous literatures (Stutzer and Frey 2008; Abou-Zeid et al. 2012; Olsson et al. 2013; Martin et al. 2014; Legrain et al. 2015) suggest that an individual's daily travel satisfaction is expected to be influenced by their commute characteristics and socio-demographic characteristics. These commute characteristics include their commute mode, commute time, commute distance and commute attitudes. From active travel to public transport to the activities individuals engage in during transit such as relaxation, and productive use of the commute time, to availability of transport facilities, the quality of transport infrastructure, the intrinsic value (positive utility) found in the commute, and commuting behaviours / characteristics all influence the travel satisfaction experienced (Páez and Whalen 2010; Ettema et al. 2012). Furthermore, socio-demographic characteristics such as age, gender, working hours per week, household characteristics (presence of dependents etc.), availability of personal vehicles, and other non-work activities among others have also been shown to affect the travel satisfaction of the individual (García et al. 2007; Dolan et al. 2008; Philp and Wheatley 2011; Wheatley 2014; Wu et al. 2019). Thus, the commute characteristics and the socio-demographic characteristics of the individual affects their travel satisfaction and and overall well-being (satisfaction with life).

Subjective well-being has been shown to be influenced by many factors (Argyle 1999; Diener 2009; Lucas and Diener 2009; Brockmann 2010; Ziegler and Schwanen 2011; Green et al. 2014), and daily travel satisfaction has be observed to influence subjective well-being (Stutzer and Frey 2008; Olsson et al. 2013; Morris and Guerra 2015b). As such, it is proposed that travel satisfaction also influences subjective well-being (see figure 2.6). Since commuting characteristics and socio-demographic characteristics are directly related to travel satisfaction, these two thus have a secondary influence on subjective well-being (see figure 2.6). Furthermore, previous studies have shown that the subjective well-being of an individual is influenced by their socio-demographic characteristics and travel satisfaction, and this ultimately has an impact on their overall well-being (Diener and Seligman 2004; Olsson et al. 2013). Therefore, travel satisfaction has both primary and secondary effects on overall well-being (life satisfaction) through subjective well-being; socio-demographic characteristics have both primary and secondary effects on overall well-being (life satisfaction) through travel satisfaction and subjective well-being; and commute characteristics have primary effects on overall well-being (life satisfaction) through travel satisfaction and subjective well-being. Figure 2.6 shows the conceptual relationship across commuting characteristics, socio-demographic characteristics, travel satisfaction, subjective well-being and overall well-being (life satisfaction).

Figure 2.6: Conceptual Relationship



**Solid black line arrows represent primary relationships; solid blue line arrows suggest inter-relationship; broken line arrows represent secondary relationships*

Source: Author from a review of literature

2.7 Other Explored Pathways

The research also focussed on two other pathways. These pathways are discussed succinctly below:

Previous studies on travel and well-being have been focused on the hedonistic aspect of well-being. As De Vos et al. (2013) suggested, travel research and subjective well-being may be better understood if a combination of both eudaimonic and hedonistic aspects are both considered in its measurement. Therefore, this research would seek to evaluate commuting and well-being variables based on these dimensions. In other to do this, the measurement scales adopted would include both aspects of well-being (hedonism and eudaimonia).

Finally, various authors have suggested that spill-over effects experienced from journey times have been known to impact on the performances of activities and moods at the destination (Van Rooy 2006; Hennessy 2008; Bergstad et al. 2011; De Vos et al. 2013; Santhosh 2015). These spill-over effects can result in short-term or long-term feelings. However, little or no knowledge exists to explain the duration or extent of these feelings. For example, although studies have shown that experiences during commute to work affects work productivity, it cannot be explained if this effect is registered immediately or later.
For better understanding of the spill-over effects, an examination of the concept is explored to understand inherent concepts and issues as discussed by previous research.

2.7.1 The Spill-over Effects

Many studies have been conducted on the after-effects commuting has on the individual's physical and psychological health, family and work relationships (Wener et al. 2003; Van Rooy 2006; Hennessy 2008; Westman et al. 2013; Santhosh 2015). These after-effects have been termed spill over effects and they can be broadly divided into short term or long-term effects.

Previous studies have been able to show that spill-over effects do occur from the commute experience and these have very detrimental long-term effects on the physical and mental well-being of the individual. Increased heart rate levels and blood pressure which are directly related to increased risks of cardiovascular diseases and suppressed natural body immunity are long term aftereffects of commuting (Singer et al. 1974; Krantz et al. 1988; Herbert and Cohen 1993). In a more recent study (than the previous studies) by researchers at Washington University in St Louis, Missouri, USA, long commutes to work impacts negatively on stress levels and may be hazardous to health since this is associated with bigger waistlines,

increased weight, higher blood pressures and lower fitness levels, which are common predictors for diabetes, cardiovascular diseases and some forms of cancer (Reuters 2012).

More recent studies have further established that active commuting such as walking and cycling do have a positive impact on the physical and mental health, and individuals that partake in it have shown higher levels of psychophysiological well-being when compared with their counterparts who use other commute modes (Humphreys et al. 2013; Martin et al. 2014). However, the focus of this research is on the relationship between the short-term spill-over effects and the well-being of the individual over time. Schimmack (2008) argued that overall life satisfaction and psychological well-being are determined by 'domain-specific satisfaction' which includes satisfaction with work, family, leisure etc. Following from this, Ettema et al. (2010) established that travel (which includes commuting) is another potential domain-specific satisfaction that affects overall life satisfaction and psychological well-being (also referred to as subjective well-being). There has been evidence suggesting that unresolved daily hassles can last a while even long after the activity has ended and this can add to subsequent pressures on other activities (Kohn and MacDonald 1992). Studies have suggested that commuting stress have been linked to absentee-ism, feelings of frustration, irritation, anxiety, general annoyance, low employee morale, job satisfaction and residential satisfaction, especially among women (Novaco et al. 1990; Evans and Carrère 1991; Novaco et al. 1991; Koslowsky and Krausz 1993; Koslowsky et al. 1995; Koslowsky et al. 1996).

Until recently there has been no evidence to suggest that commuting stress might affect interpersonal relationships between employees, workplace violence, decision making, and organisational citizenship behaviour (Van Rooy 2006). Earlier research even suggested that the relationship between employee productivity and job satisfaction is weak or moderate at best (Iaffaldano and Muchinsky 1983). All these, the literature points out, are because of commuting stress. Moreover, Hennessy (2008) observed that negative experiences during the daily commute in drivers may spill over and influence the non-driving events shortly afterwards. The study provided further evidence that suggested that an increase in driver stress was directly linked to hostility, tardiness, and aggressive behaviour during the work day (especially in male drivers). Judge and Hulin (1993) had earlier suggested that job satisfaction has been able to predict employee absenteeism, tardiness, accident rates and turnover rates in an organisation. The Hennessy study further confirms the previous findings.

In a study to test the impact daily hassles have on activities at their destination, Van Rooy (2006) assessed the effects of commuting on the evaluation and hiring decisions employers make when considering job applicants. This study was based on a previous study that

discovered that candidates were evaluated less favourable when their interviewers were in a negative mood as compared to being in a positive or neutral mood (Baron 1993). The findings from this study suggested that little or no spill over effects were observed in the hiring decisions made when considering job applicants. The respondents only reported negative affects during the commute, and this did not have any impact on evaluations. The only time the spill over effect was observed during this study was when candidates were asked to evaluate clearly unqualified applicants. This made the author to conclude that spill-over effects are only engaged when the action required could be considered another "waste of time" activity. Findings also indicated that an easy commute does not necessarily increase positive affect, and a stressful commute may not reduce it either. Although, this finding agrees with what most empirical research findings about commuting and well-being have concluded regarding negative affect, it however raises new questions regarding positive affect. Remember, happiness can be simply explained as the presence of positive affect and the absence of negative affect. And in most travel and well-being studies, happiness has been used interchangeably with subjective well-being. Therefore, a higher rating for subjective well-being would mean more positive affect and less negative affect being experienced during the journey. So, if a difficult journey does not reduce positive affect and ultimately does not reduce the rating for subjective well-being, then this gives extra credence to the use of both hedonistic and eudaimonic criteria for well-being measurement as using a single form has been shown to produce varying results.

Finally, Santhosh (2015) studied the effect of commuting on organisational citizenship behaviour at the work place. Evidence from the study concluded that there is no significant relationship between commuting and organisational citizenship behaviour of employees at the workplace. However, the evidence shows that this spill-over effect was negatively correlated to commuting indicating that a longer commute time might mean a lower rating for organisational citizenship behaviour, but this is just speculative.

Asides from the aforementioned, Hennessy (2008) discovered what can be referred to as "interactive spill-over effects". He observed that evidence from previous studies suggested that spill-over effects from the workplace results in negative moods such as social withdrawal, elevated stress levels, road rage, etc., in other environments and negative moods from the home has been found to increase occupational stress, psychological distress, conflicts etc. Therefore, there is a strong possibility that this might result into a form of cyclical pattern where commuting stress leads to workplace stress, which in turns leads to home stress, and this feedbacks over and over. All of which could have repercussions on long term well-being and interpersonal relationships.

Despite all of these, an empirical study by Wener et al. (2003) observed that there was no significant relationship in the spill over effects of commuting stress at home, but the authors did observe a negative spill-over effect which would require some further research to ascertain. In sum, the results from these studies have so far been inconclusive on the short-term spill-over effects and this current research would benefit from the new evidence a study into these phenomena would bring.

2.8 Subjective Well-being Revisited – Summary

As discussed in the previous sections, subjective and objective well-being are the two main forms of well-being. While the former can be assessed by asking individuals to report on their happiness and general condition, the latter is assessed on a record of how happy the individual is at a particular period as viewed by another person using some 'objective indicators' (Kahneman and Krueger 2006). Hedonism and Eudaimonia are the two categories of subjectively experienced well-being and studies have shown there is a considerable overlap amongst these two well-being concepts. While eudaimonia accesses aspects of the individual's life that is associated with flourishing and goal actualisation, hedonism assesses mainly experiential happiness. Recently researchers in travel and well-being studies have been able to incorporate aspects of eudaimonia (specifically, the evaluation of one's life) into hedonism. Travel and its characteristics have been shown to influence the subjective well-being of the individual.

It is important to clarify going forward that subjective well-being has generated so many interests from researchers. So much to the point that it has become synonymous with the term well-being. The delineation between subjective-well-being and overall well-being is quite nuanced, and one might even say distinguishing between both concepts is arbitrary and it is only a matter of preference to the user. Both concepts have been treated separately in this research to keep their distinctiveness. However, since both subjective well-being and overall well-being ultimately refer to one concept – well-being, they will be referred to as well-being (or subjective well-being) going forward in this thesis and study. In sum, this review has been able to provide an overview of well-being vis-à-vis its definition, delineations, determinants and measurement tools. It has also been able to do the same for travel (in the context of well-being). An overview of the theoretical and conceptual frameworks that underpins the research has also been established. It is assumed that with this review the paucity in the knowledge of well-being concepts that was previously inadequate has been rectified. Also, the current state of affairs as regards the linkages across commuting and its characteristics, socio-demographics, travel satisfaction and well-being has been assessed.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

A critical review of related literature on travel and well-being has been conducted to establish the relevance of a study like this. As this research seeks to bridge the gap and improve upon previous researches, this chapter begins with an overview of the study area, then goes on to reiterate the research questions and the purpose of the research. The research design is presented next detailing the data to be collected, and how the data would be collected, the variables to be measured, recruitment and sampling procedure, and the survey exercise amongst others is discussed. This is followed by an overview of the survey exercise including discussions on the pilot and main survey stages. The chapter concludes with an outline of the analysis to be conducted and a summary. Further details on the study (survey exercise, questionnaires, etc.) can be found in appendix IV of the appendix section at the end of the thesis.

3.2 The Case Study Area

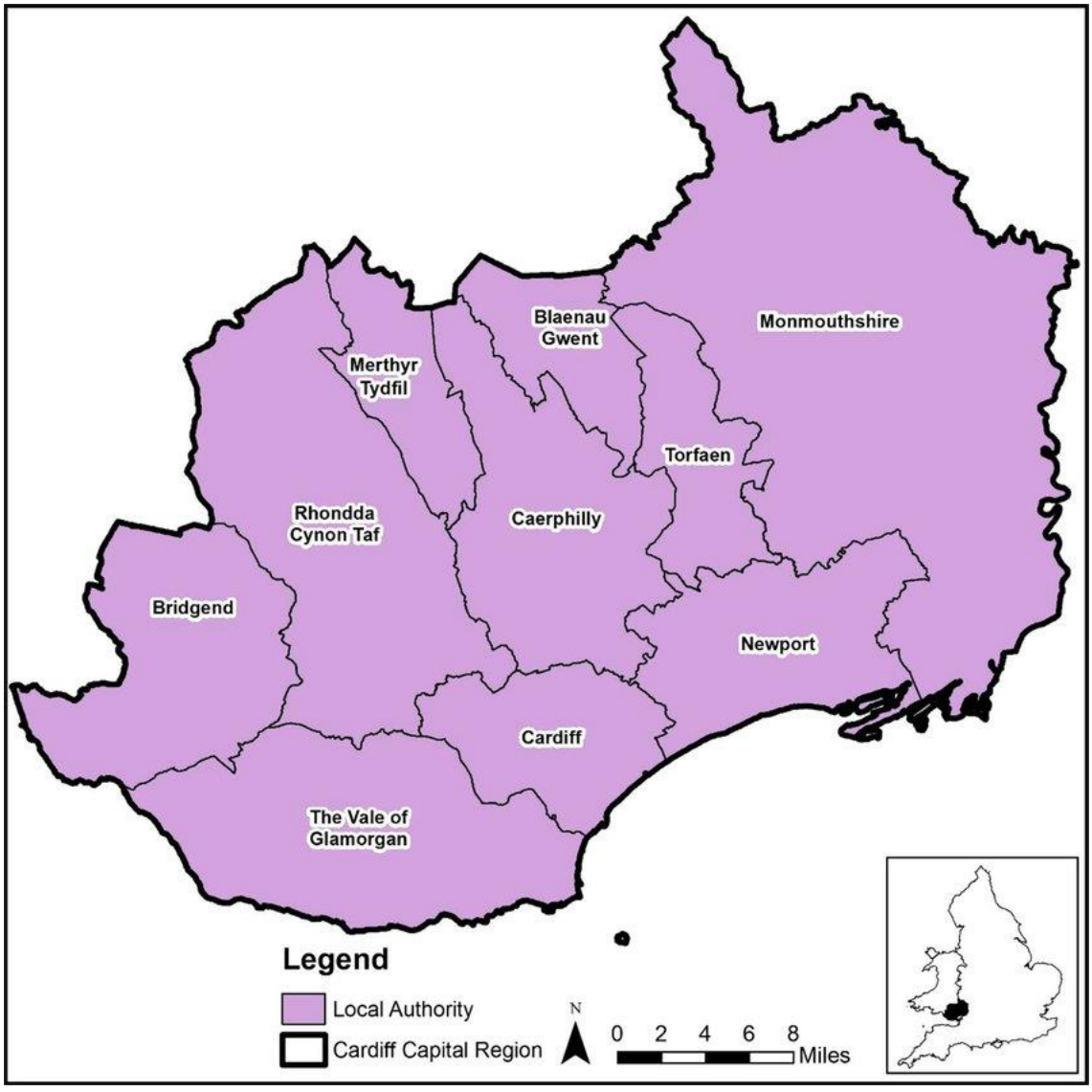
3.2.1 Geography

The city of Cardiff (hereafter called Cardiff) is the county town of the historic county of Glamorgan (now South Glamorgan) located within the Cardiff Capital Region (CCR), South Wales (see figure 3.1). The CCR (which should not be confused with the Cardiff Urban Area) although does not exist in any formal operational capacity, covers the ten local authority areas of Cardiff, Newport, Torfaen, Caerphilly, Monmouthshire, Blaenau Gwent, Merthyr Tydfil, Rhondda Cynon Taff, Vale of Glamorgan and Bridgend (see figure 3.1). According to Parkinson and Karecha (2006), Cardiff is the largest urban area in Wales serving as the administrative capital and is promoted as the nation's economic centre. Hence the researcher's choice of Cardiff within the CCR as the case study area for this research.

In terms of actual geographical location in relation to nearby populous cities, Cardiff is a city in the south-east of Wales, located on the M4 motorway 68 kms to the east of Swansea and 71 kms to the west of Bristol (243 kms to the west of London). Cardiff is a relatively compact city covering an area of about 140 square kms with a population density of 2,505 persons per square km with an ethnically diverse population of 362,756 (StatsWales 2019). The centre of Cardiff is relatively flat and is bounded by hills on the outskirts to the east, north and west. Its geographic features were influential in its development as the world's largest coal port, most

notably its proximity and easy access to the coal fields of the south Wales valleys. The highest point in the authority is Garth Hill with an altitude of 307 metres above sea level (Thomas 1989). Cardiff is bordered to the west by the rural district of the Vale of Glamorgan – also known as The Garden of Cardiff – to the east by the city of Newport, to the north by the South Wales Valleys and to the south by the Severn Estuary and Bristol Channel. The River Taff winds through the centre of the city and together with the River Ely flows into the freshwater lake of Cardiff Bay. A third river, the Rhymney flows through the east of the city entering directly into the Severn Estuary.

Figure 3.1: The Cardiff Capital Region



Source: Beel et al. (2018, p.8)

Cardiff is separated into 29 electoral wards covering the same area as the communities they are named after (see figure 3.2). Plasnewydd, Gabalfa, Roath, Cathays, Adamsdown and

Splott ward on the north and east of the city centre, and Butetown, Grangetown, Riverside and Canton to the south and west all make up what is referred to as “inner Cardiff” (CardiffLife 2007). The inner-city areas to the south of the A4161 road (which links the city centre with the M4 motorway and otherwise called the "Southern Arc") with the exception of Cardiff Bay, are some of the poorest districts of Wales with low levels of economic activity (Hooper and Punter 2006). However, Gabalfa, Plasnewydd and Cathays north of the 'arc' have very large student populations, and Pontcanna is a favourite for students and young professionals. Penylan, which lies to the north east side of Roath Park, is an affluent area popular with those with older children and the retired (University 2019). To the west is Ely, Caerau and Fairwater which contain some of the largest housing estates in the United Kingdom and are poor areas with high numbers of unemployed households. Although Culverhouse Cross (situated in Ely) is a more affluent western area of the city (Hooper and Punter 2006).

In an arc from the northwest to the northeast of the city the wards of Heath, Birchgrove, Gabalfa, Mynachdy, Llandaff North, Llandaff, Llanishen, Radyr, Whitchurch & Tongwynlais, Rhiwbina, Thornhill, Lisvane and Cyncoed are situated. Lisvane, Cyncoed, Radyr and Rhiwbina contain some of the more expensive housing in Wales. The wards of Pontprennau & Old St Mellons, Rumney, Pentwyn, Llanrumney and Trowbridge all lie further east. Pontprennau is considered the newest 'suburb' of Cardiff while Old St Mellons has a history going back to the Norman Conquest in the 11th century (Council 2006). The villages of St. Fagans, Creigiau, Pentyrch, Tongwynlais and Gwaelod-y-garth make up what can be considered ‘rural Cardiff’ (Council 2006).

Figure 3.2: Electoral Wards in Cardiff

Ward	Communities	Other geographic areas
1 Adamsdown	Adamsdown	Cardiff city centre, Roath
2 Butetown	Butetown	Atlantic Wharf, Cardiff Bay, Cardiff city centre, Tiger Bay
3 Caerau	Caerau	Cyntwell, Culverhouse Cross
4 Canton	Canton	Cardiff city centre, Leckwith, Victoria Park
5 Cathays	Cathays and Castle	Blackweir, Cardiff city centre, Cathays, Cathays Park, Maindy
6 Creigiau & St. Fagans	Pentyrch (Creigiau ward) and St Fagans	Coedbychan, Capel Llanilltern, Rhydlafar
7 Cyncoed	Cyncoed	Roath Park, Lakeside
8 Ely	Ely	Culverhouse Cross, Michaelston-super-Ely
9 Fairwater	Fairwater	Pentrebane
10 Gabalfa	Gabalfa	Mynachdy, Maindy, Heath
11 Grangetown	Grangetown	Cardiff Bay, Cardiff city centre, Saltmead, International Sports Village
12 Heath	Heath	Birchgrove
13 Lisvane	Lisvane	
14 Llandaff	Llandaff	Danescourt
15 Llandaff North	Llandaff North	Hailey Park, Lydstep Park, Mynachdy, Gabalfa
16 Llanishen	Llanishen	Thornhill
17 Llanrumney	Llanrumney	
18 Pentwyn	Pentwyn	Llanedeyrn
19 Pentyrch	Pentyrch (Gwaelod-y-Garth and Pentyrch wards)	
20 Penylan	Roath	
21 Plasnewydd	Plasnewydd	Roath, Cardiff city centre
22 Pontprennau & Old St. Mellons	Old St. Mellons and Pontprennau	Llanedeyrn Village
23 Radyr & Morganstown	Radyr & Morganstown	Morganstown
24 Rhiwbina	Rhiwbina	Pantmawr, Rhydwaedlyd, Wenallt
25 Riverside	Riverside	Cardiff city centre, Llandaff Fields, Pontcanna, Sophia Gardens
26 Rumney	Rumney	
27 Splott	Splott	Pengam Green, Splott, Tremorfa

28 Trowbridge	Trowbridge	St Mellons estate, Cefn Mably, Wentloog
29 Whitchurch & Tongwynlais	Tongwynlais and Whitchurch	Blaengwynlais, Bwlch-y-cwm, Coedcefngarw, Coryton, Cwmnofydd, Graig-goch, Llandaff North

Source: StatsWales and Google Compilation

3.2.2 Economy

As the capital city of Wales, Cardiff is the main driver for development and growth in the Welsh economy making up nearly 20% of the total Welsh GDP (Douglas and Clifton-Fearnside 2002) and an employment rate of 70.9% even though the population of Cardiff is only 10% of the Welsh population (StatsWales 2019).

As the primary business and finance centre in Wales, there is a strong representation of business and finance services in the local economy. Along with the education, health and public administration sectors, the business and finance sector have accounted for around 75% of Cardiff's economic growth since 1991 (Council 2004). Notable companies such as Admiral Insurance, Dwr Cymru/Welsh Water, Principality Building Society, British Gas, Brains, and BT, all operate large national or regional headquarters and contact centres in the city (Cardiff 2019). Other major employers include NHS Wales, the National Assembly for Wales, Cardiff University, Transport for Wales, and BBC Wales. Furthermore, the city serves as a major hub for employment within the country with commuters into the city making up 40% of Cardiff's workforce (see table 3.1).

Table 3.1: Commuting patterns in Wales, Cardiff and the CCR

Measure	Wales			Cardiff		
	Year			Year		
	2016	2017	2018	2016	2017	2018
Total number of working residents	1,405,100	1,426,000	1,445,200	167,900	172,200	187,900
Number of people commuting out	90,000	94,700	95,400	28,000	32,600	30,500
Number of people commuting in	40,000	42,200	47,700	89,900	90,200	98,300

Detailed commuting patterns within the CCR

Residential location	Workplace location										
	Bridgend	Vale of Glamorgan	Cardiff	Rhondda Cynon Taf	Merthyr Tydfil	Caerphilly	Blaenau Gwent	Torfaen	Monmouthshire	Newport	Other outside Wales
Bridgend	41,300	1,400	8,200	2,100	*	*	*	*	*	*	2,600
Vale of Glamorgan	2,600	31,900	22,200	1,500	*	*	*	*	*	*	2,300
Cardiff	2,100	*	157,400	3,800	*	3,900	*	*	*	7,000	4,600
Rhondda Cynon Taf	4,600	*	22,000	56,900	4,200	4,400	*	*	1,400	2,300	5,000
Merthyr Tydfil	*	*	2,900	2,800	15,800	2,000	*	*	*	*	1,300
Caerphilly	*	*	16,400	3,900	1,800	38,400	1,700	2,500	*	9,900	3,300
Blaenau Gwent	*	*	1,900	*	1,500	2,300	14,800	2,500	4,200	1,300	1,200

Torfaen	*	*	2,900	*	*	1,000	*	23,000	2,300	6,900	1,500
Monmouthshire	*	*	2,100	*	*	*	600	1,300	26,500	3,200	2,800
Newport	*	*	8,400	*	*	2,000	*	4,100	4,000	43,000	3,400
Other outside Wales	*	*	5,000	*	*	*	*	*	8,100	*	*

Source: StatsWales (2019)

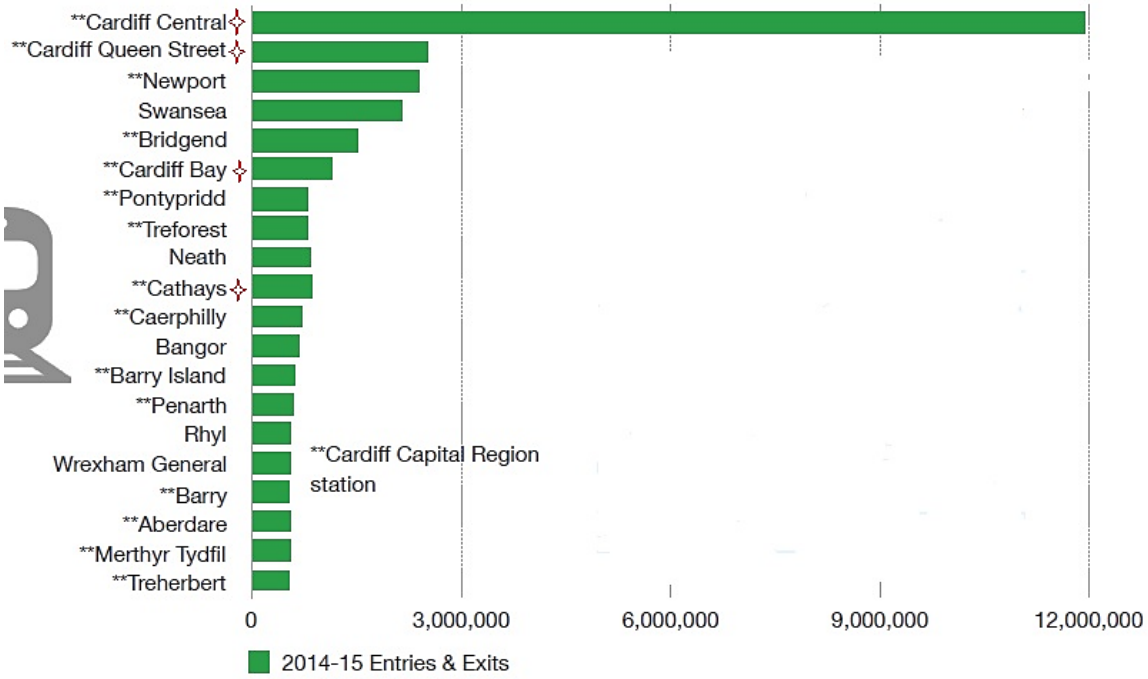
3.2.3 Commuting and Travel

According to Webb (2017), the commuter belt into Cardiff stretches across South Wales to Bristol, predominantly consisting of bus, train and car commuters although cycle and pedestrian commuters are also identified. Moreover, as a major transport hub in Wales, it is the focus of many arterial rail and road routes connecting the city to the rest of Wales and the United Kingdom at large.

The Cardiff Central railway station is the largest railway station in Wales with nine platforms, and over 12.5 million passengers passing through yearly (NetworkRail 2018). It provides direct services to Bridgend and Newport; long-distance, cross-Wales services to Wrexham, Holyhead, Bristol, Birmingham, Manchester and London. Cardiff Queen Street railway station is the second busiest in Wales and is the hub for routes via the Valley Lines services that connect the South Wales Valleys and the Cardiff suburbs with the city centre. Along with Cathays and Cardiff Bay stations, these four stations are some of the busiest stations in Wales (see figure 3.3) and are situated within the centre of the city. Cardiff also has a suburban rail system known as the Valleys & Cardiff Local Routes operated by Transport for Wales. In all, there are eight lines which serve 20 stations within the city.

Cardiff has a comprehensive bus network, with providers including municipal bus company Cardiff Bus (routes within the city and to Newport, Barry and Penarth), NAT Group (cross-city and to Cardiff Airport), Stagecoach South Wales (to the South Wales Valleys) and First Cymru (to Cowbridge and Bridgend). National Express and Megabus provides direct services to major cities such as Bristol, London, Newcastle upon Tyne and Manchester. By comparison, Cardiff Bus is the dominant bus operator in the city carrying 100,000 passengers daily across 64 routes. The service also boasts of a turnover of £27million and employs around 720 people (Wales 2015).

Figure 3.3: 20 busiest stations in Wales by station entries/exits (2014-2015)

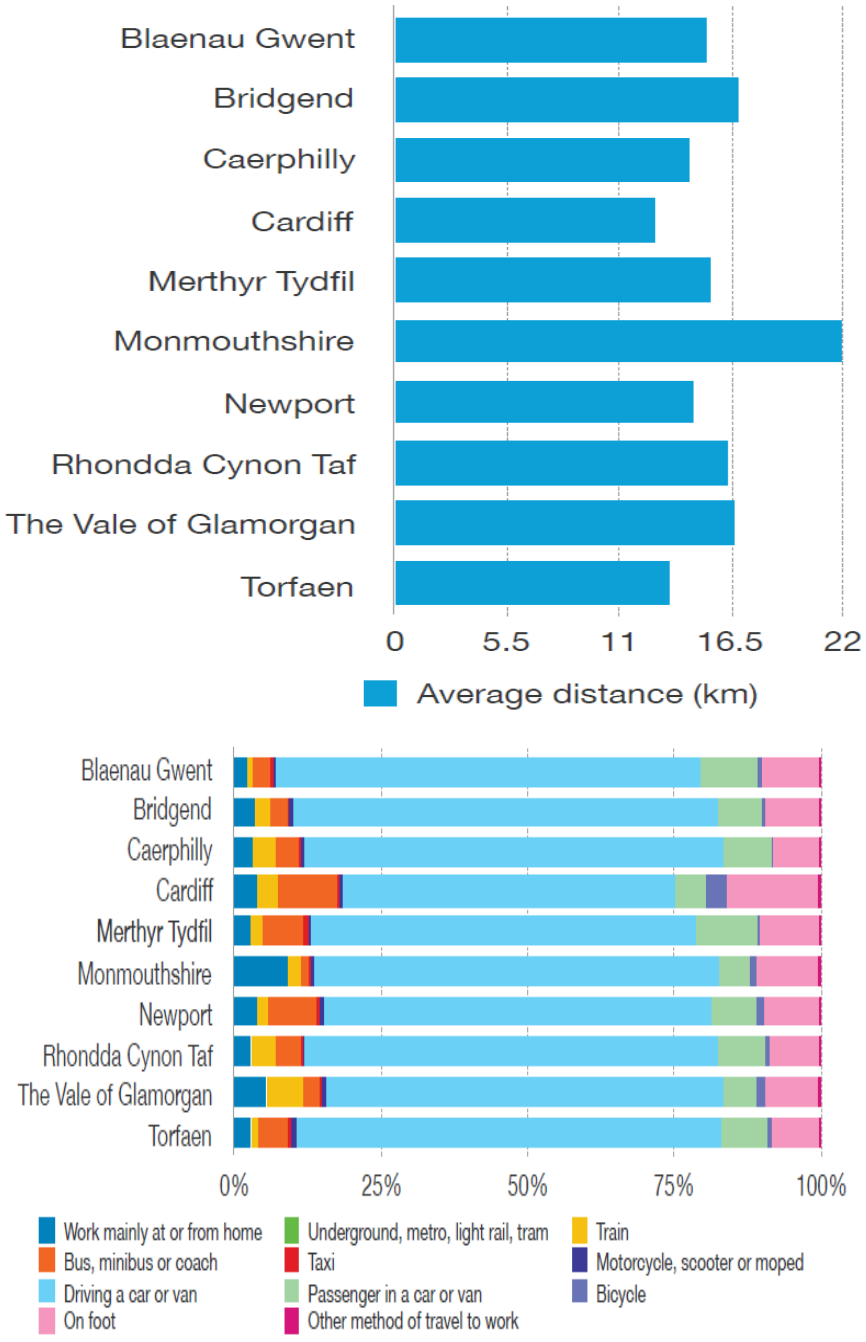


Source: Webb (2017, p.34)

Recently, there is a proposed integration of heavy rail and the development of light rail and bus oriented public transport service within the CCR called the South Wales Metro. This is all part of creating a multimodal interlinked transport system that would allow for easier access to employment and other services (especially for the more deprived local authorities within the CCR) within Cardiff and most especially to the wider CCR area. The South Wales Metro has been split into three phases with the cost of the works and sequential changes to the delivery timeline being spread over these phases. Furthermore, the potential benefits of the SW Metro would see the project over a 30 year period, generate £4bn to the regional economy, add 420,000 people to the regional transport network and create 7,000 new regional jobs (Welsh-Government 2018).

Within the CCR, car commuting accounts for over 70% of the preferred mode of travel despite increases in rail travel, with commuters travelling an average of over 12km, and the longest journeys of about 22km originating from the Monmouthshire area (see figure 3.4).

Figure 3.4: Average Commute Distance and Commute Mode in the CCR



Source: Webb (2017, p.33, 34)

This is also true for Cardiff as the census aggregate data show that the most frequently used mode of travel to work is the car. Furthermore, walking and bus commuters also recorded higher average numbers. Perhaps train commuters (who registered the lowest average of the modes) is also in theme with the wider region figures showing that despite the increase in train journeys, they still fall short of the averages for other transport modes.

Table 3.2: Daily Commuting by Modes in Cardiff

Modes of travel	Minimum	Maximum	Mean
Work from home	34	264	125
Train	11	415	111
Bus/Minibus/Coach	64	620	338
Car/Van	904	3497	1890
Passenger Car/Van	100	259	171
Bicycle	33	443	123
On foot	117	1806	514

Source: ONS Population Census 2011

Furthermore, based on commuting data, Table 3.3 shows the commuting flows into and outside the region. Cardiff acts as a key destination for workers from the Vale of Glamorgan, Rhondda Cynon Taf, Caerphilly, and Bridgend; while Newport is an important destination, albeit at lower volumes, for workers from Torfaen, Monmouthshire and Caerphilly. Connections between Cardiff and Newport, the two principal urban nodes, are almost equal in either direction which is rather surprising considering Cardiff is the larger area.

Table 3.3: Daily Commuting flows into and out of Cardiff and Newport

Modes of travel	To Cardiff	From Cardiff	To Newport	From Newport
Cardiff	–	–	5679	5474
Vale of Glamorgan	20,507	4592	913	98
Rhondda Cynon Taf	18,753	4432	1574	474
Caerphilly	9744	3223	7680	1454
Bridgend	B6030	2123	369	217
Newport	5474	5679	–	–
Torfaen	2246	1010	5741	3497
Merthyr Tydfil	2155	1124	93	222
Monmouthshire	1665	1126	4155	2395
Blaenau Gwent	978	0	1495	194
*Bristol**	*1340*	*1283*	*n/a*	*2364*
*Swansea**	*1921*	*n/a*	*150*	*77*

* *locations are outside the region*
Source: ONS Population Census 2011

3.3 Research Questions and Rationale

This study seeks to examine the potential links across commuting attitudes, commuting characteristics (i.e., commuting time, commute distance mode and commute mode), travel satisfaction, subjective well-being, and overall well-being.

More precisely, the research is designed to answer the following questions:

i. What role does an individual's satisfaction with daily travel play on their subjective and overall well-being?
ii. What role does the individual's commuting characteristics (i.e., commute time, commute distance and commute mode) play on travel satisfaction and subjective well-being?
iii. How has the socio-demographic conditions affected the travel satisfaction of individuals, and have these conditions affected their subjective well-being?
iv. What role has the individual's commute experience played on their moods?
v. Is there any association across the individual's commuting behaviour, travel satisfaction and subjective well-being? and
vi. How has access to basic amenities, a good neighbourhood, and urban transportation infrastructure and resources influenced commuting patterns and behaviours?

These research questions all stem out from consideration of the various variables (factors, activities, and conditions), such as commute characteristics, socio-demographic variables etc., that have been identified as being of critical significance to influencing travel (especially commuting) and well-being from a review of literature.

Where this study differ from other similar studies is that it employs a real-time online data tracking measure to record travel satisfaction, commute distance, commute time, mood and well-being over a period while also establishing a connection across these concepts – the first study in travel and well-being research to do this. Previous studies and related analyses have been heavily reliant on cross-sectional data between either commuting and travel satisfaction or commuting and subjective well-being with the link across commuting, travel satisfaction and subjective well-being primarily missing. Unlike previous research efforts, this research works towards formalising the relationship across commuting behaviour, travel satisfaction, subjective- and overall well-being (life satisfaction) and also exploring the spill-over effects of commuting on both work life and family life.

This research captures and explains the effects of commuting behaviours and travel satisfaction on subjective well-being via a temporally-dynamic approach. In this regard, this study develops and implements a longitudinal data collection approach – i.e. repeated observations of commuting patterns and travel satisfaction instead of the use of a cross-sectional survey synonymous with most studies of this nature. Using this approach, the research is able to analyse, among other things, the influence of multiple satisfying (or

dissatisfying) journeys and/or activities over time on commuters' positive (or negative) evaluation of their overall well-being (life satisfaction). This is because it is assumed that the overall well-being can be influenced by the accumulated effects of other domain-specific activities, daily travel in this case (Hennessy 2008; Ettema et al. 2010; De Vos et al. 2013). Furthermore, empirical evidence from the measurement of subjective well-being in activities and travel has been able to indicate that travel plays a role in the well-being of people, and the timeframe for measuring travel well-being is important due to the dynamic nature of well-being.

3.4 Research Design

3.4.1 Adopted Approach in Data Collection

3.4.1.1 Traditional Approach

Generally, with studies of this nature, data collection is conducted empirically using a questionnaire survey and a form of travel or self-reporting activity dairy. This data collection method varies from study to study but mostly includes questionnaires in the form of online surveys (Kolodinsky et al. 2013), postal questionnaires (Humphreys et al. 2013), telephone surveys (Giuliano and Narayan 2003) and face-to-face interviews (Best and Lanzendorf 2005).

These surveys may include single or multiple scales measuring affective-state scales, cognitive-state scales (subjective well-being), and travel satisfaction, as well as socio-demographic information, work information, commuting information, and attitudinal questions in one form or another. Examples of these measuring scales are the Satisfaction with Travel Scale (STS) and the Satisfaction With Life Scale (SWLS) widely used for measuring travel satisfaction and cognitive subjective well-being (Bergstad et al. 2011; Olsson et al. 2013) respectively. Other scales that have been used to measure well-being include Swedish Core Affect Scales (SCAS), Subjective Happiness Scale (SHS), Meaning of Life Questionnaire (MLQ), Beliefs about Wellbeing Scale (BWBS), and the Personal Wellbeing Index (PWI) among others (Ettema et al. 2011; McMahan and Estes 2011b; Bhullar et al. 2013). Some studies have employed data from secondary sources such as the Understanding Society (previously known as the British Household Panel Survey – BHPS) (Chng et al. 2016) and the German Socio-Economic Panel Study – GSOEP (Lorenz 2018). These secondary sources of data are large scale panel surveys covering many people over a large area for a long period of time. Due to the longitudinal nature of these panel surveys, researchers can study the way a particular concept evolved over time saving a great deal in money and time costs.

However, the most common form of data collection is the use of a combination of questionnaire survey and a form of self-reporting travel (or activity) diary (Prelipcean et al. 2017). This travel diary often takes the form of a day reconstruction model where the respondents are told to think back over the previous day, week or month to report their travel characteristics including commuting mode, distance and time during that period (Kahneman et al. 2004).

There were also variability in the sample size tested in studies of this nature, ranging from less than 100 – for example, the 51 respondents sampled by (Wener et al. 2003), to tens of thousands such as the 23,441 respondents of the (Morris and Guerra 2015a) study. Generally, secondary sources of data give a larger pool of samples involving minimal costs on the researcher while primary sources would yield less respondents.

3.4.1.2 Modern Approach – Smartphone Application Data Collection Tool

Data from travel related studies form the basis for transportation modelling, optimization of transportation services, and the improvement of the general quality of life (Stopher and Greaves 2007). In addition to the aforementioned traditional methods for collecting data for travel surveys, other examples include computer-aided telephone interviews and personal interviews, computer-aided self-interviews, mail-back questionnaires, traffic counting at cross-sections or intersections and analyses of transport schedule inquires (Nitsche et al. 2014). However, most of the above methods come at high costs in time and money, are affected by non-response issues and under-reported journeys (Abraham et al. 2006; Groves 2006). Under-reported trips are the major debilitating issue that plague travel diaries or surveys (Groves 2006). Ideally, trip information from travel diaries usually contains spatial information (i.e., an origin and destination), which can also be aggregated to form larger information clusters. Furthermore, travel survey data also requires temporal information for each trip, i.e., start time, end time, and its duration which allows determining travel times and average trip durations. This is where the use of the Global Positioning System (GPS) based technologies come in. These GPS devices – often combined with Geographic Information Systems (GIS) – have helped mitigate to a great extent the challenges of traditional travel data collection. Recently, due to technological advancement, smartphone devices (already equipped with GPS services) have been tested and used as travel diaries and activity models for spatial research (Pinter 2015; Ferreira et al. 2017; Harding et al. 2017). Asides from the aforementioned solutions smartphone devices provide, they also help mitigate against scales and self-reporting errors that most times fail to provide a dynamic picture in understanding

population – an issue common with traditional methods such as interviews and questionnaire surveys (D'Andrea et al. 2011).

Typically, smartphone devices contain several internal micro-electro-mechanical systems (MEMS) sensors (e.g., accelerometer, magnetometer, gyroscope) and two different positioning services that offer precise self-positioning via assisted-GPS and approximate network positioning using GSM Cell IDs and WIFI SSIDs through the processing of signal information from multiple cellular towers within the closest proximity (Eagle et al. 2009; Raento et al. 2009; Nitsche et al. 2014). This means a rich set of data resource can be generated for travel and mobility studies. Although, travel diaries and activity models allow the reconstruction of detailed movement through space as people go about their daily activities, smartphone devices avoid many of the accuracy problems synonymous with self-reporting (Golledge and Stimson 1997; Murakami and Wagner 1999; Stopher et al. 2007). Furthermore, because smartphone devices incorporate into people's lives seamlessly, they are effective tools for capturing people's reactions and information in real-time (Raento et al. 2009; Ahas et al. 2011).

Nevertheless, the most common problems of smartphone devices for travel surveys are signal losses in places outside of mobile network coverage such as underground transportation systems, high battery-power consumption resulting in a limitation in usual smartphone performance, and the generation of location-based data of users carrying the device for daily travel which may be a privacy issue for most people (Asakura and Hato 2004; Bierlaire et al. 2010; Gong et al. 2012). Another critique of the use of smartphone devices was discussed by Sophie Roux and her colleagues on a study of the use of technologies in survey. While lauding the advantages of smartphone-based travel surveys, they argued that participants in these surveys may have a particular profile mostly corresponding with one or a combination of higher income, higher education or greater mobility (Roux et al. 2009). In other words, not all socio-demographic groups can be effectively reached without specific incentives when smartphone-based survey is concerned.

As earlier discussed, Geographic Information Systems (GIS) is often combined with GPS data to accurately provide spatio-temporal information from smartphone-based travel surveys (Pearce et al. 2006). One of the greatest challenges facing the use of GIS is the acquisition of detailed data sources that contain spatial information that is useful for travel surveys. These spatial data can be acquired using either primary or secondary data collection methods. Primary spatial data are often collected using either psychometric methods (through the surveys of individuals reporting on the phenomena being studied) and/or ecometric methods

(through direct observations from fieldwork exercises) (Raudenbush and Sampson 1999; Troped et al. 2001; Mujahid et al. 2007). The GPS information from a smartphone-based travel survey data enables the direct integration of spatial information into GIS using a combination of both psychometric and ecometric primary data collection (Stopher et al. 2008; Stopher et al. 2017). Contrarily, secondary spatial data are sourced and collected from external sources such as administrative data (e.g., from a census), commercial data (e.g., from market research companies), internet resources (e.g., company websites or Google Street view), and phone directories and are relatively cheaper to obtain than primary spatial data (Thornton et al. 2011). After the spatial data must have been collected, the address location information of participants could then be matched with a digital spatial dataset that includes all addresses within the area of interest mapped to the longitude and latitude coordinates of the area (Longley et al. 2005). This process is called geocoding and is essential to the production of maps illustrating the phenomena under scrutiny.

As previously discussed, real-time measures would be the most efficient method of capturing travel information (see previous chapter) and is being adopted by this study. Therefore, the increasing popularity of smartphone devices – this offer real-time measures – opens new possibilities as far as travel survey data collection is concerned. An 'early' example in travel and well-being research of a study that explains how real-time travel information capture can be conducted is the Human Mobility Project by John Palmer and colleagues in 2013. In their project, Palmer et al. (2013) recruited volunteers around the world to share their GPS and cellular tower information on their daily movement and activities, and respond to real time location-based surveys using their mobile devices on the Android Mobile platform. This project sought to understand such phenomena as how activity spaces influence daily living, how spatial segregation affects other aspects of life, and how subjective well-being may be influence by spatial location. The open-source Android mobile application was downloaded into the respondent's device, then the subject proceeded to register and activate the application consenting to participate in the study. The downloaded application would run in the background of the respondents' devices recording location estimates based on cellular tower signals at the pre-set intervals. For measuring subjective well-being, the respondents were asked the question, "How happy are you?" with the response rated on a 5-star scale (ranging from 0 to 5). The researchers observed that they recruited 270 respondents from 13 countries, studied their travel patterns and demographic characteristics, and have them respond to real-time surveys triggered by their location in a cost effective and timely manner. This illustrates the great potential and limitless opportunities in adopting mobile technologies in social science research.

In order for a smartphone application to be effectively used as an activity or travel tracking tool, it must fulfil certain conditions. Based on their previous experience in building mobility tracking apps, Bucher et al. (2016) proposed the essential requirements for mobility tracking on a smartphone. These are summarised as follows:

i. reasonable accuracy of recorded GPS points (it should be possible to reconstruct a close approximation to the actual route taken by applying map matching algorithms).
ii. capability to automatically identify that transport activities are taking place, without any indication by the user (no need to activate and deactivate the GPS tracking functionality).
iii. availability of pre-processing algorithms able to organize GPS data into routes and activities (sections of a route, covered with a single means of transport), in case different transport modes are used in the same route.
iv. effectiveness in identifying the transport mode.
v. low battery power consumption, allowing usual phone usage during the day, recharging the phone over the night; and
vi. near real-time, automated accessibility to the collected location data (via an application programming interface, i.e., an API) for the researcher.

The aforementioned criteria informed the review of related smartphone applications that can be used (and in some cases have been adopted) in travel and well-being research. These apps have been ranked in a hierarchical order from the best to the worst according to their usability, features, and ease of procurement. They are as follows:

1. **Sense.DAT** – This is a smartphone application that measures, analyses and stores outdoor travel behaviour and experience data. It is developed by DAT Mobility (a Dutch company specialising in mobility monitoring, modelling, managing and planning. The app is available to download for free for Android and iOS mobile operating platforms. It uses the GPS, GSM, WIFI, Accelerometer, and Magnetometer on installed devices to automatically detect travel time, origin and destination, travel mode and travel route. It can also automatically detect start and stop times of a journey as well as the travel split legs while giving users the ability to register travel purpose. It has a travel recall function in the form of an embedded map that allows each trip to be viewed, approved and corrected by the user, if necessary. The application also offers a sampling option that allows for additional questions to be asked about travel behaviour and it is highly customisable.

2. **TRavelVU** – TRavelVU is a proprietary software that can be downloaded for free on both the Android and iOS mobile platforms. It is developed by a Swedish company – TrivectorAB (en.trivector.se/it-systems/travelvu/) – specialising in transport, IT systems, and business development. The application uses the embedded GPS, GSM, WIFI, Accelerometer, and Magnetometer sensors on the installed device for collecting travel survey data. It can automatically detect 7 travel modes and the register has the option to further choose 10 modes. It also incorporates software algorithm to collect information on time, travel length, speed, and route for every travel leg split of the journey and activities between trips. Maps are embedded in the application to show how the transport system is used by different groups and to help recall travel to modify incorrect information if necessary. The only basic functionality the app lacks is the ability to automatically start and stop trips, which it makes up for with the automatic travel destination detection feature. Also, survey questions are currently not embedded in the application, but it is rated highly due to its customisability.

3. **BetterPoints** – The BetterPoints application also incorporates a mobile rewards system developed by an English company, BetterPoints (betterpoints.org) that enables users to collect points for their active travel activities. These points can later be redeemed for real-world vouchers and gift cards to major retail and groceries stores within their locality. The application is a proprietary software available for free download on both the Android and iOS mobile operating platforms. Initially designed as an active travel reward tool, the application is intuitive using the GPS, GSM, WIFI, Accelerometer, Magnetometer on the installed device to detect a wider range of activities. The application can automatically detect travel, start and stop times of a journey, travel split legs within a journey, and the travel mode. It presents users at the end of each journey with information about the distance travelled, duration of travel, calories burnt, their carbon footprint and travel time. An origin-destination map is also generated showing users their travelled routes although this information cannot be altered. It also does not have sampling options but because of its high customisability, this can be added to the design.

4. **MyExperience** – This application was adopted by Friman et al. (2017a) in their study to understand how work commutes affect mood experienced after the commute. Though the application's only activity tracking feature is automatically detecting travel, it makes up for this in additional features. The application allows sampling options, which enable surveys about mood, travel satisfaction, positive critical incidents, non-travel related occurrence, and travel characteristics such as travel duration, travel

mode and travel companion amongst others to be embedded in it. Since the survey records were to be taken at various intervals, the application had a system of notifications and reminders prompting users at the various stages.

5. **SmartMo** – This is a mobile travel survey tool developed by EasyMobiz (easymobiz.com), an Austrian mobile application development agency. Berger and Platzer (2015) employed this application in their Smart Mobility project in Austria. The application is available for download on both the Android and iOS mobile platforms and uses the GPS, GSM and WIFI sensors on the devices it is installed on for tracking activities. Although the application can automatically detect both movements (or travel activities) and travel journey split legs, users would have to manually start and stop their journeys for a record of travel origins and destinations. They would also have to manually register their travel mode for each journey. While the application does not contain a sampling option (which means that survey questions would have to be linked to the app), it benefits from having a travel recall function which allows users to modify the automatically generated travel information if incorrect. Also, the highly customisable nature of the application makes it suitable to include gamification elements (such as points collection for distance walked, etc.).

6. **MyPhysicalActivities** – This is an experimental smartphone application developed by Zhou et al. (2016) to detect and classify travel modes automatically. The application was designed to use a 3-layer classification to recognise travel modes to a very high accuracy (although this was after travel was reconstructed and mapped). It was tested on a small number of people (12) and it achieved a 93.8% accuracy rating. The application was available on only the Android mobile operating platform and used the installed device GPS and accelerometer sensors to detect 4 travel modes of walking, running, biking, and in-vehicle, while also detecting users' rest position (stationary mode). It could also automatically detect travel split legs, but users had to manually record start and stop times of their journeys for origin and destination information.

7. **SbNavi** – The SbNavi is a satellite route navigation mobile application developed by an innovation high-tech Greek company called Sboing (sboing.net). This application is a proprietary software that was repurposed for use in the METPEX project (Susilo et al. 2017). The project was aimed at developing a Pan-European standardised measurement tool to measure passenger experience across whole journeys, whilst considering wider human socio-economic, cultural, geographic and environmental factors. The application is available on both the Android and iOS mobile operating

platforms and uses the GPS sensors on the device installed on for tracking activities. Aside from automatically detecting travel activities, users must manually start and stop any form of activity tracking. Also, type of activity, travel mode and travel split legs also must be manually added. Where the application lacks in functionality, it makes up for this in additional features. It has a sampling option which enables real-time questions to be embedded allowing researchers to track travel variables at various intervals. Furthermore, being a route navigation application in its basic form, the application uses custom maps based on free maps and OpenStreetMap to better provide travel information estimates depending on the type of vehicle, weather, road conditions etc. This feature also helps improve its accuracy and efficiency at predicting travel variables and providing travel information over time.

8. **Nemo-Phone** – The Nemo-Phone project in Vienna, Austria employed a smartphone-based travel data collection tool that distinguishes between 8 different travel mode categories (walk, cycle, motorbike, car, bus, tram, metro, train) (Nitsche et al. 2014). The application, a proprietary software, developed for the purpose of the study was available on the Android mobile platform throughout the duration of the study. It uses the GPS, GSM, WIFI, Accelerometer, and Magnetometer sensors in the devices installed on for tracking travel activities. Due to the additional sensors it uses, the application can map location and speed information without a GPS signal lock. It can also automatically detect travel split legs as well as automatically detect travel activities. However, users would have to manually start and stop trips in other to register the journey.

9. **rMove** – Calastri et al. (2017) used the rMove application in their study to capture social network structures, lifetime events and short-term travel and activity information. This smartphone application was designed to collect household travel information, daily tasks information, social network information, energy and residential choices to mention a few. It is a proprietary software developed by RSG Inc (rmove.rsginc.com) available to download for free on both the Android and iOS mobile operating platforms. It uses the GPS, GSM, WIFI, Accelerometer, Magnetometer, and other embedded sensors to accurately track users' activities. The application can record travel information such as position, speed, and route using multiple sensors embedded in the device installed on, so does not necessarily require a GPS signal. The application also includes a sampling option which asks participants to answer short surveys about travel mode, travel cost, travel purpose etc. after completing the journey. The application tries to learn from the user's answers and travel behaviour over time to

suggest modifications to their recently completed journey. Furthermore, maps are embedded in the application to help recall journey allowing users to correct a trip or modify their travel information if displayed incorrectly. However, the application lacks in functionality. Asides from automatically detecting travel, the application does not automatically detect travel mode and travel split legs. Users also have to manually start and stop a journey to record origin and destination information for their journeys.

Table 3.4: Summary of Related Apps Features*

SUMMARY											
S/N	**Name**	**Developer**	**Licence and Price**	**How It Works**							
				Operating System	**Sensors Used**	**Automatically Detecting Start/Stop**	**Automatically Detecting Travel**	**Detecting Travel Split Legs**	**Detecting Travel Mode**	**Detecting Travel Purpose**	**Detecting Travel Destination**
1	Sense.DAT	DAT.Mobility (dat.nl/en/products/sensedat/)	-Proprietary software -Free in the App Store	Android and iOS	GPS, GSM, WIFI, Accelerometer, Magnetometer, and other embedded sensors	Yes	Yes	Yes	Yes	Yes	Yes
2	TRavelVU	TrivectorAB (en.trivector.se/it-systems/travelvu/)	-Proprietary software -Free in the App Store	Android and iOS	GPS, GSM, WIFI, Accelerometer, Magnetometer, and other embedded sensors	No	Yes	Yes	Yes	Yes	Yes
3	BetterPoints	BetterPoints (betterpoints.org)	-Proprietary software	Android and iOS	GPS, GSM, WIFI, Accelerometer, Magnetometer, and other embedded sensors	Yes	Yes	Yes	Yes	No	Yes
4	MyExperience	-N/A -Most likely authors	N/A	Android and iOS	GPS	No	Yes	No	No	No	No
5	SmartMo	EasyMobiz (easymobiz.com)	-Proprietary software -price N/A from app store	Android and iOS	GPS, GSM, WIFI	No	Yes	Yes	No	No	No
6	My Physical Activities (MPA)	-N/A -Most likely authors	-N/A -Can be obtained for free from the authors (presumably)	Android	GPS and Accelerometer	No	Yes	Yes	Yes	No	No
7	SbNavi	Sboing (sboing.net)	-Proprietary software -Price from free (community version) to $10 (platinum version)	Android and iOS	GPS	No	Yes	No	No	No	No
8	Nemo-Phone	N/A	N/A	Android	GPS, GSM, WIFI, Accelerometer, Magnetometer	No	Yes	Yes	Yes	No	No
9	rMove	RSG Inc (rmove.rsginc.com)	-Proprietary software. -Free in the App Store	Android and iOS	GPS, GSM, WIFI, Accelerometer, Magnetometer, and other embedded sensors	No	Yes	No	No	No	No

Source: Author

**see appendix III for a detailed discussion of these apps.*

This research employs a novel methodology (using a smartphone based collection tool) that has been only sporadically applied across cities in Europe: Dublin, Rome, and Stockholm (Friman et al. 2017a; Susilo et al. 2017); North America: Georgia and Toronto (Zhou et al. 2016; Harding et al. 2017); Africa: Dar es Salaam (Zegras et al. 2017), and Australia (Greaves et al. 2015) to understand travel and well-being. As previously mentioned, the city of Cardiff is the geographical focus of the study with a pilot study conducted within Cardiff University. The BetterPoints smartphone application developed by BetterPOints.org was the preferred choice for reasons summarised in the following section.

3.4.2 Rationale for adopting the BetterPoints Smartphone App

The following sums up the rationale behind the BetterPoints app's choice as the travel activity tracking tool for the study ahead of other applications reviewed:

i. After ranking the app selections based on features and availability, the BetterPoints app was one of the highest-ranking travel survey data collection applications reviewed.
ii. The customisable interface of the application would provide the perfect opportunity to fine tune various aspect of the application to suit the research goals.
iii. The willingness of the developers to collaborate with the research all but made the process very smooth. Taking various elements from previous travel survey applications, the BetterPoints developer team was able to provide a tailor-fit version of their application for the research purpose.
iv. And finally, being a UK based organisation, it was easier getting in touch with the developers, arranging meetings and discussions whether in-person or online over the course of the project.

3.4.2.1 The BetterPoints App

i. **What it does** – The app primarily functions as a rewards system which enables users to collect points for their (active) travel activities.

ii. **User Interface** – The developers have offered a clean user interface which is quite easy to follow. Although the menu items could have been ordered and labelled better. This was one of the areas where the developers had to customise the interface during the survey exercise to help navigating around easily.

iii. **How it works** – Users must register to at least a programme to be able to collect points on the app. To collect points, users would simply click on the "start" button, choose the travel activity mode at the beginning of their journey and stop this when they complete the journey. Conversely, users can opt to have their travel information automatically recorded to avoid the burden of constantly having to start and end journeys manually. At the end of the journey, the distance travelled, duration of travel, calories burnt, carbon footprint and travel time are presented to the user along with an origin-destination map of the completed journey. The user is also rewarded with the points at this stage.

iv. **Privacy Policy** – This was one of the most important issues that needed to be clarified with the developers. The BetterPoints app developers assured that data protection policy stores and processes all personal information in accordance with the Data Protection Act 1998 as well as the new General Data Protection Regulation (GDPR) guidelines of 2018. The data collected from users is divided into two main categories; contact information (including name, address and email address) which allows BetterPoints to communicate with the user, and the usage data which includes information about the use of BetterPoints' products and services (i.e., the app). This information is collected either manually when the users register, log in directly with the app, or automatically during the use of the app. BetterPoints also assured that any information collected via the app is only shared with the researchers.

v. **Drawbacks** – The major drawback to this app is that it does not recognise trip-legs and the user must manually change this during the journey. For instance, if the user walks/cycles from their home to the train station, takes the train, and then walks/cycles to their workplace, the user must manually enter these trips as separate journeys and they are recorded as such. Although the app tries to address this trip-leg problem by asking the user what part of the whole journey the selected travel mode was, this function may be best suited for people using just one travel mode. This issue was later rectified by asking users to report readings for the main travel mode. Also, software algorithm was also updated to allow the app to automatically record travel activity and determine different travel modes as used by the user – when it was requested as part of the survey. Furthermore, being a customised version of the app tailored to our study travel information can be recorded for not only active travel, but also travel by other modes (e.g., car, public transport) automatically in real-time.

In conclusion, although the BetterPoints app has its shortcomings, it offered a lot of potential and was one of the better apps for this research.

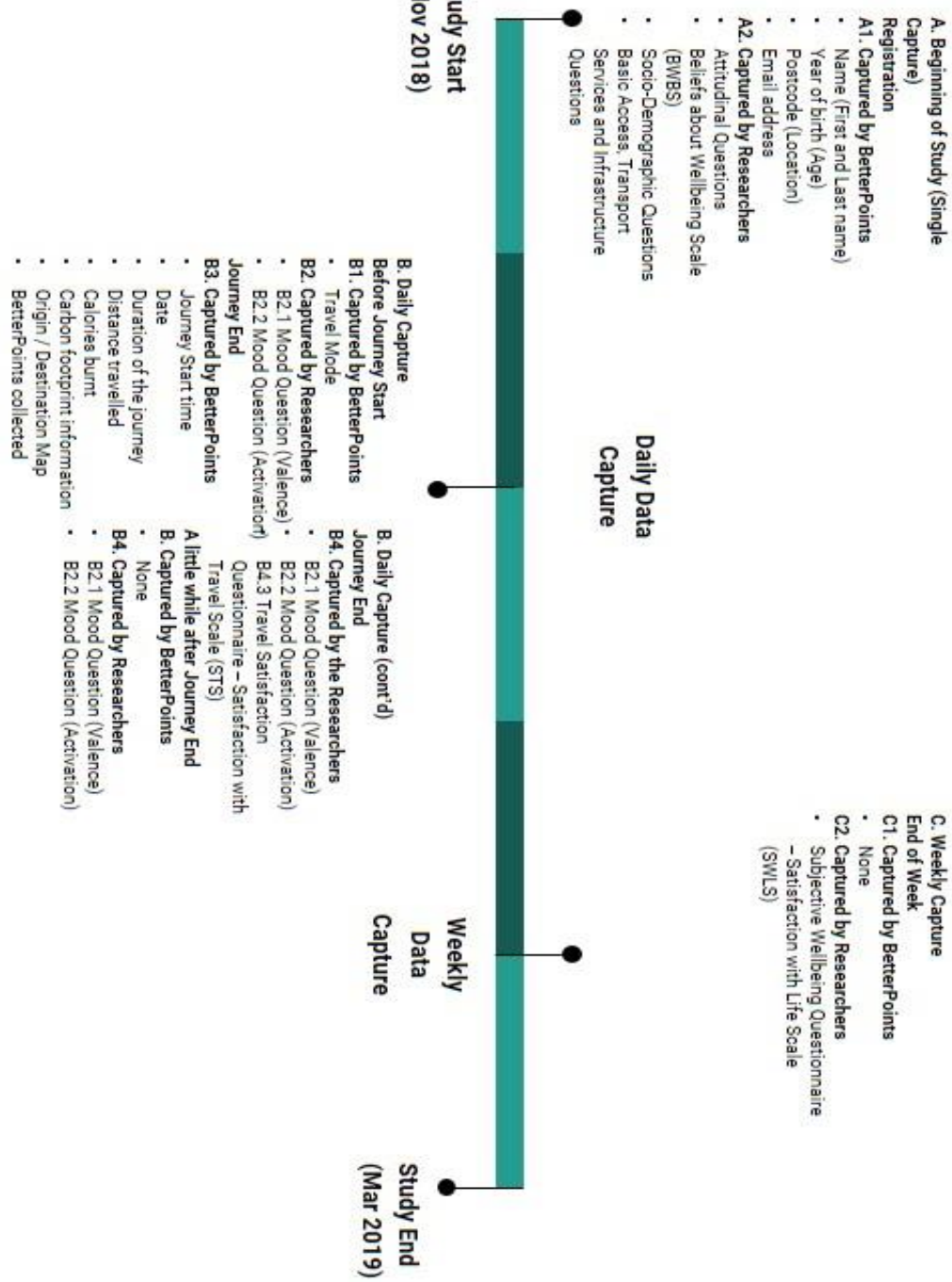
3.4.3 Research Survey Overview

This research effectively builds on the capabilities of the BetterPoints app to establish the relationship across commuting, travel satisfaction, subjective and overall well-being using the app and ad-hoc surveys embedded therein (please see appendix IV for a detailed plan).

The respondents were required to start and stop the tracking of their journeys and indicate the travel mode used or they could opt for the automatic tracking feature that monitors tracking passively (in the background). However, this was advised against to help avoid battery drainage issues on their smartphones. Upon registration, asides from the information required by BetterPoints, the respondents were required to complete attitudinal and lifestyle questionnaires as well as questionnaires on their beliefs about well-being, socio-demographic information, and neighbourhood quality and existing transport infrastructure. This was to help construct a 'personality' profile for the respondents which would help during the analysis stage. These questionnaires (referred to as the Initial Survey Questionnaire) were hosted on the Qualtrics Online Survey platform and were subsequently linked to the BetterPoints app.

Daily travel information was collected, recorded and stored automatically once the respondent initiated and ended the journey. A travel satisfaction survey embedded in the app was taken by the respondent immediately after each daily journey to and from work. A mood-based question embedded in the app was also required to be answered by respondents before, immediately after and a little while after (around 90 minutes) after every journey to both the workplace and back home. The respondents were also required to complete the subjective well-being scales adopted in the study on a weekly basis (see figure 3.5 for a timeline of the process).

Figure 3.5: Research Timeline



Source: Author

3.4.4 Variables Measured

Having looked at the various methods adopted, and variables explored by previous studies into commuting and well-being, the following describes the variables that were measured during this research and how the measurements were done to sufficiently provide answers to the research questions earlier postulated.

3.4.4.1 Commute Characteristics

The variables that were considered under this section included the commute mode, commute time, and commute distance. Traditionally, a travel diary or activity model would have been employed for this. However, the BetterPoints app was used in this case. Through the pre-programmed algorithms on the app, it could automatically detect when the individual is in motion calculating the speed of motion to determine the mode of transit. However, for this research, it is advised that the user manually start and stop the tracking function to initiate interaction with the app and avoid battery drainage issues. Evidence from a similar study using a similar process suggests that this allows the users full control over their activity tracking and saves their phone's battery life (see Friman et al. 2017b).

3.4.4.2 Subjective Well-being / Travel Satisfaction

As subjective well-being is composed of two states, affective and cognitive states, this would be important in choosing an appropriate scale of measurement. All the well-being scales adopted in this study have been used by similar studies with most of them already put through a test-retest reliability check. A test-retest reliability was also conducted in this study for all the scales used and is described in the analysis chapter. The adopted well-being scale – the Satisfaction with Life Scale (SWLS) – was displayed at the end of each week to be completed by respondents. The SWLS (Diener et al. 1985; Pavot and Diener 1993) measures overall well-being (life satisfaction). This scale consists of 5 statements asking respondents to indicate how much they agree to them on a 7-point Likert scale (see appendix IV). Also, the Beliefs about Well-being Scale (BWBS) (McMahan and Estes 2011b) which combines the hedonistic aspects of well-being with four theoretically meaningful dimensions of eudaimonia was administered to respondents upon registration at the beginning of the study and was included in the Initial Survey Questionnaire. This scale consists of 16 statements believed to be factors resulting in the respondent experiencing a higher degree of well-being. Respondents were asked to indicate how much they agree to these statements on a 7-point Likert scale (see appendix IV).

Regarding travel satisfaction, the Satisfaction with Travel Scale (STS) was administered on respondents at the end of each daily journey to and from work. The STS (Ettema et al. 2011; Friman et al. 2013) measures both affective and cognitive dimensions of travel satisfaction. Affective dimension is divided into two components of travel satisfaction ranging from positive activation (e.g., enthusiastic) to negative deactivation (e.g., bored) – PAND – and from positive deactivation (e.g., calm) to negative activation (e.g., stressed) – PDNA. The cognitive dimension consists of 3 cognitive evaluation statements about the journey asking respondents to indicate how much they agree to them – CE. All the responses to both dimensions are indicated on a 7-point Likert scale (see appendix IV for details). The STS, SWLS, and BWBS have been adopted because they are designed to include both the affective and cognitive components of daily travel and the subjective well-being which was one of the pathways the research was looking to explore (as discussed in the literature review).

3.4.4.3 Basic Access, Transport Services and Infrastructure

The variables considered here included the respondents' access to basic amenities, healthcare, and a safe, satisfying place to live. Furthermore, the condition of transportation facilities, infrastructure & services within the respondents' residential area were also accessed. This scale comprises of 9 statements rating the accessibility to services, transport infrastructure and a sense of security within the neighbourhood from a review of literature. This scale is measured on a 7-point Likert scale ranging from "extremely dissatisfied" to "extremely satisfied". All of which helps provide information on the neighbourhood quality of respondents. This is included in the Initial Survey questionnaire to be completed by the respondents upon registration at the beginning of the study.

3.4.4.4 Socio-demographic Information

The socio-demographic variables measured were age, income, gender, household size, and employment status, amongst others. This helps provide a context in the analysis for the relationship across commuting mode, travel satisfaction, well-being and the socio-demographic characteristics of respondents. This is important because there is evidence that studies based on travel diaries / activity models show notable spatial differences which is dependent upon the respondents' socio-demographic characteristics (Best and Lanzendorf 2005; Blanchflower and Oswald 2008; Dolan et al. 2008; Wu et al. 2019). This information was included in the Initial Survey questionnaire completed by the respondents upon registration at the beginning of the study.

3.4.4.5 Spill-over effect

The spill-over effects measured was based on the respondents' moods before the journey upon arriving at the workplace and back home. This included simple questions put forward to the respondents immediately before leaving their starting location (home or work), immediately after arriving at their intended destinations (work or home) and about 90 minutes afterwards. These questions were embedded in the app and the user was prompted to answer them at the specified interval. This is based on evidence from similar studies and in the review of related literature (see Hennessey, 2008; De Vos, 2017; Friman et al. 2017b). Respondents' moods were measured by answering the question, ''How do you feel right now?" rated on two 7-point Likert scales adapted from Friman et al. (2017b). One 7-point Likert scale measured valence of mood (how happy) with the left endpoint ''very sad, depressed, displeased" and the right end-point ''pleased, very glad, joyful". The other 7-point Likert scale measures activation of mood (how alert) with the left endpoint ''very passive, sleepy, dull" and the right end-point ''awake, lively, very active" (please see appendix IV for details).

3.4.4.6 Attitudinal and Commuting Patterns / Behaviours

Attitudinal and commuting patterns / behaviours is measured with the 'Commuting Behaviour Scale'. This scale comprises of 13 statements on commuting attitudes and behaviours from the review of literature. The elements of the scale include statements about active, car and public transport commuting. Moreover, statements on sustainable transport use and self-evaluation were also included. This scale was measured on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree". This questionnaire was administered to respondents upon registration at the beginning of the study and was included in the Initial Survey Questionnaire. More details on the data collection and associated questions can be found in appendix IV.

3.4.5 Justification for adopting a Questionnaire method of Data Collection

In empirical research, data collection is very important to the generation of new knowledge and questionnaires are one of the many data collection tools used. Invariably, questionnaires are useful for gathering data about people, their behaviour, experiences and social interactions, attitudes and opinions, and awareness of events (McLafferty 2003; Flowerdew and Martin 2005). Furthermore, especially in the field of human geography where travel and well-being studies is situated, questionnaires pose standardized, formally structured questions to a group of individuals, selected as a sample of a broader population in order to gather

opinions, attitudes, knowledge, or suggestions that aid the researcher(s) in obtaining information about the particular phenomena under study (Canales et al. 1994; McGuirk and O'Neill 2016).

Pozzo et al. (2019) opines that although it is easy for the terms “survey” and “questionnaire” to be used interchangeably, there is a considerable variation between the two – “survey” generally refers to the method, while “questionnaire” refers to the specific instrument that is applied. However, from a review of literature, questionnaires have been described as the instrument itself (Hernández-Sampieri and Torres 2018), as a method, a design, a type of research, a standardized instrument (Archenti and Piovani 2007), and a structured interview (Canales et al. 1994), among others. Therefore, whichever way the researchers may term it, questionnaires serve as tools for teasing out original information from a population. In consideration of all these, the questionnaire is adopted in this research as a data collection method because it is designed as an instrument within the framework of the study which is based on the specific objective of developing a novel data collection technique for studying the relationship across commuting, travel satisfaction and well-being – i.e., using various measurement scales to elicit responses from the sample. Also, questionnaires can be used to summarise the overall results, while providing a comprehensive description of the phenomena (in this case, the concepts being studied) (Bird 2009).

Asides from the aforementioned, some other advantages of a questionnaire data collection include: they are one of the more practical research tools especially as they can be cost-effective, enabling extensive research over a large or geographically dispersed population (Sue and Ritter 2012); and they are extremely flexible and can be combined effectively with other complementary data collection techniques (such as interviews) to provide more in-depth perspectives on studied concepts (McGuirk and O'Neill 2016). Although the advantages of using a questionnaire data collection method outweigh the disadvantages, there are some potential problems with the approach. Perhaps, the greatest disadvantage of questionnaires is the impersonal way of administering them which may result in participants misinterpreting the questions due to the inability to clarify them or worse, failing to provide a response to the questions being asked (Archenti and Piovani 2007; Taherdoost 2016). Another problem of the use of questionnaires – which may/may not stem from the previous problem – is the difficulty in obtaining a high rate of fully completed questionnaires which in turns impact on the number of observations used for the analysis (Hernández-Sampieri and Torres 2018).

3.4.6 Recruitment and Sampling Procedure

3.4.6.1 Pilot Study

Prior to the main data collection, a pilot study involving graduate students and staff in Cardiff University was conducted to identify potential issues and validate the quality of the data. Potential respondents in the pilot study were individuals over 18 years of age working and/or studying on campus. The data collection campaign for the pilot phase was expected to last a total of four weeks per respondent over a survey period of 8 weeks. Each respondent was expected to provide a minimum of three working-days of commute activity information and complete the related surveys in order to claim and redeem points. They were also expected to provide one weekend-day of travel activity and complete related surveys in addition to the weekdays' information. These points were awarded for completing surveys and providing commuting information for the specified days.

The first step was some form of awareness program for recruiting prospective participants (staff and students) within the university to test-run the application. Of great importance here is the collaboration with very influential stakeholders identified to ensure the success of the process. This partnership was thought to be very beneficial because stakeholders could serve as a source of funding or a major driving force in the study's awareness program. However, very little help was gotten from the central University channels regarding publicity and awareness. Almost all the publicity and awareness campaign were done by the department's (School of Geography and Planning) own communications officer. Contacts were also established with the communications teams in the Student Union, Doctoral Academy and the Research Innovation Services at the University to help in mobilising participants through advertising on social media platforms, engagement with the students' union communications team and the internal e-mail distribution lists of members of staff and students. Unfortunately, these also did not yield many positive returns. As a result, the number of respondents recruited for the pilot study was significantly affected.

3.4.6.2 Main Study

Regarding the Cardiff-area wide campaign, the initial target stakeholders were the big employers within the city (such as the University, and regional organisations e.g., BBC Wales etc.), the local communities where the study would be conducted and/or the local council authority. Participants were to be informed through the distribution of flyers, posting on social media platforms, and the organisation e-mail distribution lists of the partnering stakeholder(s).

The main data collection phase was to employ a broad demographic base to obtain a representative sample. Furthermore, this was to enable the understanding of any nuance within the population regarding commuting and well-being and how these determine the potential linkages between all the other elements under investigation. As later discussed, the target of a representative sample across diverse demographics was not realised.

Incentives are also important in a study of this nature to keep participants excited as well as motivated. It is essential that participants are informed about the benefits of participating in the exercise since it is true that if individuals perceive that they would have some form of influence on policies especially those that shape their lives and local communities, they would be willing to participate. Furthermore, the partnering stakeholders can also be motivated if they perceive some form of benefit to their organisation or reputation within the local or regional area. Therefore, the incentives assured by the study ranged from cash prices and valuable items for individuals, to organisational benefits such as employee sustainability reports or well-being information. The cash prices for individuals were to be paid for from the research allowance allocated to the researcher from the University. However, the reception from other stakeholders approached in the city was not very welcoming. Much to the point that the overall response rate of the study was affected as discussed later. In addition, the BetterPoints app had a reward system already in place where points were garnered for travel activities and these were then exchanged for real world benefits such as store vouchers, cinema tickets and other leisure engagements amongst others. A reward system matrix was designed in conjunction with the BetterPoints team for the purpose of this study and tested during the pilot phase (which is discussed later).

Once participants have been recruited, a form of activation process detailing tutorials on how the BetterPoints app is used, the roles of the participants, and the guidelines to follow during the study was provided. The data collection phase involved obtaining information on the personal, subjective well-being, travel activity as well as relative mood of the respondents through the tracking of their travel activities. Respondents downloaded the BetterPoints app on their mobile devices and proceeded to register and activate it indicative of their consent. Ahas et al. (2011) described this as “active positioning”, where the respondents consent to be tracked and have the required data obtained from their devices or devices’ traces when using a smartphone application tool for the data collection process. The respondents’ GPS position is mapped to the closest cell tower(s) at the start of their journeys to determine their origin location. Information on the respondent’s postcode and GPS locations were collated and compared to the data from the indices of multiple deprivation and Google maps to determine their exact residential density. Also, in the advent of a loss in GPS location data, the

smartphone's GSM network and WIFI (WLAN sensor) offers alternative localization tools ensuring all avenues are covered as regards accurate data tracking and localisation. This is necessary so as to obtain an understanding of the distribution of respondents (social segregation and socio-demographic characteristics inclusive) which are important to studies of self-reports to workplaces based on travel diaries or activity models (Ellis et al. 2004) and to also help with geocoding for the travel satisfaction and well-being GIS maps later produced.

After the journey, the respondents answered a travel satisfaction questionnaire embedded in the mobile application. Furthermore, mood questions are embedded in the app and respondents were required to provide answers at the specified intervals before and after the journey. Afterwards, the respondents submit the results of their completed journeys including answers to the questionnaire survey to a server which is then made available to the researcher.

As with the pilot study, the Cardiff area-wide study was also expected to last a total of four weeks per respondent over a survey period of 8 weeks. Each respondent was expected to provide a minimum of three working-days of commuting and one weekend-day of travel activity in travel satisfaction data to be able to claim and redeem points. However, due to the low response rates these figures were later revisited as discussed later. Communication and application support was provided throughout the period of the study. During the study survey period, respondents were afforded inline help through the user-friendly tutorial information section in the BetterPoints app as well as an online support for further queries. A webpage and a mailbox were both created to help provide information and support to users. Users also received daily prompts reminding them to complete and submit their completed journeys as well as some helpful tips on how to properly manage their information during the survey period.

3.4.7 WELCOM Study

3.4.7.1 Pilot Phase

For the pilot phase and going forward, this research was called the WELCOM (WELl-being and COMmuting) Study. As explained earlier, the WELCOM study was designed to capture the daily patterns of commuters in Cardiff using a combination of passive on-line tracking, ad-hoc surveys embedded in the BetterPoints app and an online survey on the Qualtrics platform all done in real-time. Initially, it was expected that all the surveys would be accessed on the BetterPoints app. A summary of the survey questions and their time requirements are presented in the table 3.5.

Table 3.5: Survey Questions and their timings

S/N	Title of Questionnaire	Frequency
1	Attitudinal and Commuting Patterns	Single capture; upon registration
2	Beliefs about Well-being	Single capture; after registration
3a	Mood Questions I	Daily capture; before journey start
3a	Mood Questions II	Daily capture; journey end
3a	Mood Questions III	Daily capture; 90 mins after journey end.
4	Travel Satisfaction	Daily capture; at the end of every journey to and from work
5	Subjective Well-being	Weekly capture; end of the week
6	Socio-Demographic Information	Single capture; end of the study
7.	Basic Access	Single capture; end of the study

Source: Author

However, due to the time requirements for the different surveys and the inability of the BetterPoints programme to accommodate these temporal differences, some of the surveys had to be hosted on the Qualtrics online survey platform. Therefore, all surveys meant to be administered at the end of the study, were brought forward to the start of the survey and was called the Initial Survey to be administered via the Qualtrics platform. Also, the mood questions I and mood questions III became the pre-commute survey and post-commute survey respectively administered on the BetterPoints app. Lastly, the travel satisfaction and mood question II were merged into a single survey administered on the BetterPoints app at the completion of every journey. A revised summary table of the questions catalogue is presented below;

Table 3.6: Revised Survey Questions Catalogue

S/N	Title of Questionnaire	Frequency	Platform Hosted On
1	Initial Survey All questions on; -attitudinal and commuting patterns, -beliefs about well-being, -socio-demographic information, and -basic access	Single capture; upon registration	Qualtrics
2	Pre-Commute Survey (Mood Questions I)	Daily capture: before journey start (between 5:30AM and 9:00AM for morning commute and repeats between 3:30PM and 7:00PM for evening commute)	BetterPoints app as an in-app messaging service
3	Travel Satisfaction and Mood Questions II	Daily capture; at the end of every journey to work (morning) and from work (evening)	BetterPoints app as an in-app messaging service after the completion of every tracked journey.
4	Post-Commute Survey (Mood Questions III)	Daily capture: a little while after journey end (between 11:30AM and 1:30PM for morning commute and repeats between	BetterPoints app as an in-app messaging service.

		8:00PM and 10:00PM for evening commute).	
5	Subjective Well-being	Weekly capture; end of the week	BetterPoints app as in-app weekly reminders.

Source: Author

After the design phase of the BetterPoints app and the online survey platform were completed, a testing phase was conducted to trial these tools as earlier discussed. This pilot phase was conducted between 1 October 2018 and 29 October 2018 (a 4-week period). A selection of staff members and postgraduate students from the School of Geography and Planning, Cardiff University were contacted to help during this phase. Initially the testing phase was supposed to include members of staff and students from the different departments within the University, but as with the main study, this proved rather difficult. The lack of support from the various departments approached within the University was rather unexpected rendering the overall recruitment process very challenging. Regarding response rates, 3 out of the 4 staff members contacted responded while only 9 out of the 27 postgraduate students contacted responded (signifying a response rate of 38.7%). Respondents were provided instructions on how to use the app and survey tool (see appendix IV) and in exchange, they were to provide information on how the app operates especially in relation to bugs and niggles. Also, question ambiguity especially in relation to how easy the questions were understood, and the general wordings of the questions were also asked to be commented on.

The app de-bugging and cleaning process was done in real-time. Respondents were asked to report any errors as they noticed, and corrections were made immediately they were raised. An app developer from BetterPoints was always available to help so this made the process go on smoothly. During the early stages of the testing phase, these adjustments were being made almost daily, but as the testing went on, these petered down to every other day due to the improved stability of the app.

Also, the response rates dropped toward the end of the survey period with only 5 of the initial 12 still using the app (a drop-rate of 41.6%) at the end of the test period. As with similar studies that employed the use of a smartphone application to collect data, this drop was expected. The experience of the pilot phase helped to prepare the mind-set of this researcher in relation to what to expect when the app is finally rolled out to the public. A summary of the main errors/bugs encountered, and solutions provided during the testing phase is presented in table 3.7.

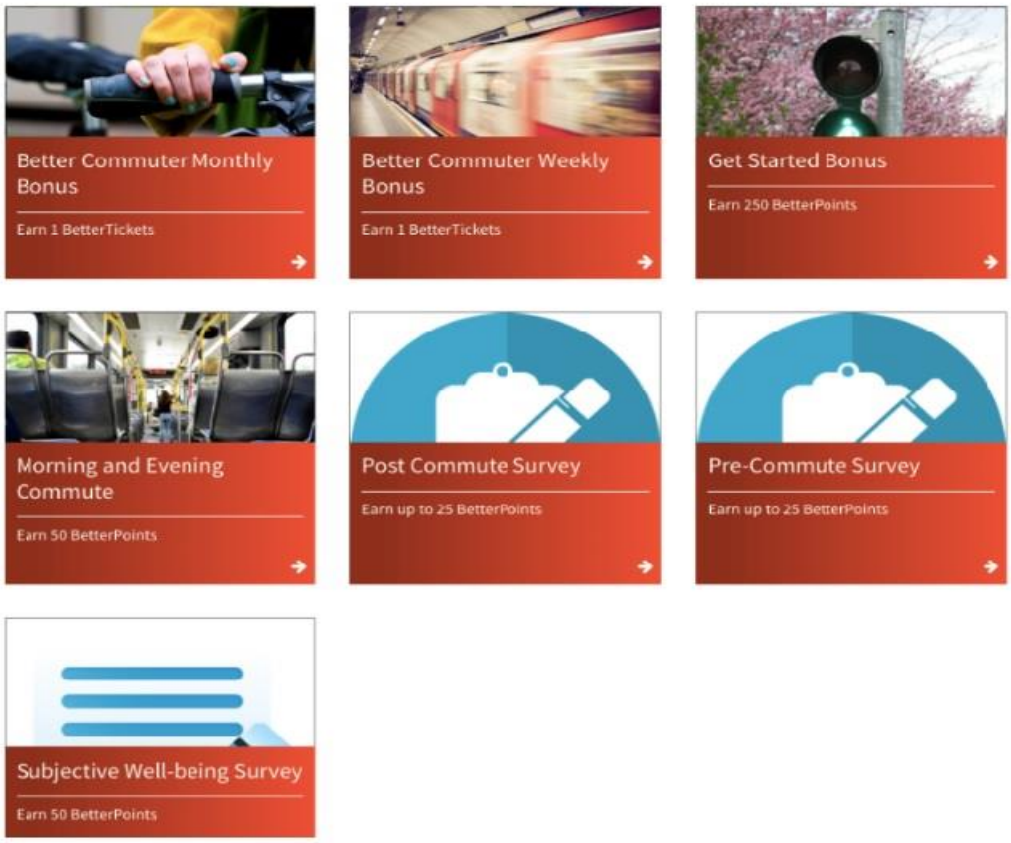
Table 3.7: Summary of major corrections made during the testing phase

S/N	Errors/Bugs	Correction made
1	Link to Qualtrics survey in the invitation email sent out keeps crashing	Link was corrected
2	Pre-commute and post-commute notifications not being received on app.	Bug was fixed, and notifications started going out. Issue was with the app learning when to push out notifications.
3	BetterPoints app notifications not being received at the appropriate time	Similar development bug issue as above, and was fixed
4	Pre-commute notification not being displayed after registration	If respondent registers for the study after the period for notification has passed, that notification would not be received.
5	The order of the questions in the survey completed after every journey (Travel Satisfaction and Mood Questions II) was making it difficult for users to respond properly	The order was changed with the mood questions coming before the travel satisfaction questions.
6	New users not getting the link to the initial survey on the app after registration.	Bug was fixed, and users would see the link to the initial survey on their timeline after registration.
7	Users suggested a reminder to log the commute activity for their journey sent to their phones after completing pre-commute surveys	A reminder to log their commute activity was added and this would show up after users complete their pre-commute survey.
8	Lag noticed when submitting responses after completing journeys and sometimes app crashing	This was due to network location issues. Users were advised they needed to be in locations where there was mobile network or Wi-Fi coverage before submitting responses.
9	Users suggested that the order to the answers provided for the mood and travel satisfaction questions be changed to enable them to understand their choices better	This was changed so that the options became better to understand.
10	Users suggested that they are made aware of the timeline for tracking and recording responses beforehand, so that they know the exact routine of doing the pre-commute survey, the tracking, and then the post-commute survey as part of their activity tracking for each journey.	A link was added to the timeline which directs the users to details on how to participate after they complete their registration.

Source: Author

Upon launching the pilot phase, the reward matrix for the study was drawn up allowing respondents to be rewarded with “BetterPoints” at various stages of the study. Respondents would get rewarded immediately when they sign up for the study via the BetterPoints app and complete the initial survey on the Qualtrics platform. Then they get rewarded every time they record and complete a journey. Points were also awarded for every mood and well-being questions answered. Finally, the respondents were awarded weekly and monthly tickets which qualifies them for a weekly and monthly bonus draw to earn bigger prizes (see figure 3.6).

Figure 3.6: Rewards Matrix



Source: BetterPoints

3.4.7.2 Main Data Collection Phase

Phase 1

Before the commencement of the study, contacts were made with employers within the city to help with recruiting participants from their organisations. Following several months of chasing up and pitching the study to various employers, 5 employers were able to be convinced. They were Cardiff University, Cardiff County Council, BBC Wales, Capital Law and Office of the Future Generations Commissioner for Wales. It was agreed that an invitation mail would be sent out to these firms which will contain details about registration and participation in the study. These invites would then be circulated to workers within these organisations who would be free to also pass on these invites to family and friends working within the city. Of all these organisations, the Office of the Future Generations Commissioner for Wales had the least number of employees of about 30 people. Cardiff University and BBC Wales have about 6,000 and 1,000 employees respectively currently working with them, and Capital Law is a mid-sized

firm based in Cardiff with about 200 employees (all workforce information were sourced from the internet). Although the Cardiff County Council has access to a panel of 5,000 people which the study was hoping to make use of, the timing of the study and the avoidance of a conflict of interest with other surveys the council was promoting at that time made it impossible. However, this researcher was optimistic, and based on the level of interest generated and the number of organisations contacted, a target sample size of 500 respondents was initially set.

Since the target population of this study was commuters who work within the city of Cardiff, the BetterPoints app had to be repurposed. Earlier in the design phase, the use of the BetterPoints app was only opened to anyone within a 5-mile radius of the city. However, having considered that some target audience may reside well outside this 5-mile radius, it was decided that the restriction be removed. Therefore, participants would be able to use the app both at home and at work even if they live outside the city. It is important to mention at this juncture that the sampling technique employed was selective and subjective due to the nature of the study (commuters within Cardiff) and the availability of respondents. This sampling style may otherwise be referred to as the purposive sampling technique (Bryman 2016).

Following the completion of the testing phase, the survey tools were rolled out to the public on 5 November 2018 through an invitation email containing details for registration and participation. This data collection phase was expected to go on for 4 weeks (for each respondent) over the next 6 weeks. Therefore, the study's end date was tentatively suggested to be between 30 November 2018 and 14 December 2018.
From the lessons learned from the testing phase, participants were required, as a minimum, to register 2 workday commuting trips (morning and afternoon/evening) and one weekend day trip (for any purpose). The questionnaires to be completed would then be sent out over the survey period as follows:

i. A set of survey questions dubbed "Initial Survey" which included attitudinal and commuting patterns, beliefs about well-being, socio-demographic information, and basic access/neighbourhood conditions questions to be answered upon registration – this was expected to take about 8 minutes.
ii. A set of questions to measure their current mood/emotion to be taken before, after and a little while after their journeys to both the workplace and back home – each of which takes about 45 seconds to complete.
iii. Another set of questions about travel satisfaction to be answered after the journey to both the workplace and back home – which also takes about 45 seconds.

iv. And finally, a weekly questionnaire on their well-being – which takes about 45 seconds to complete.

It was estimated that the total time a participant would spend daily in answering all the survey questions was 3 minutes 45 seconds (again, this was spread throughout the day).

Over the course of the initial 6-week survey period, weekly reminders were sent out to the organisations already contacted and more organisations were sought out to partner with. These reminders served as a form of alerts reminding the organisations to send out the study invites to their employees and to encourage employees pass on the invitation to friends and family working in the city. However, the level of participation did not turn out as expected. More so, that at the end of the 6-week period, only 42 participants had registered for the study. This low response rate should have been expected looking at the numbers from the pilot study. Also, Susilo et al. (2017) had a worse experience in the cities of Rome and Coventry where 0 and 6 respondents respectively opted to download and use the smartphone application promoted for their METPEX project study despite the publicity and incentives offered.

Phase 2

Due to this poor return in respondent numbers, it was decided that the study would run for another 10 weeks. Some subtle changes were implemented in the data collection mechanism and the rewards package was made more attractive. The following changes were adapted to the programmes to make it more attractive to participants:

i. Participation in the study was reduced to only 3 full days of commuting activity including providing responses to the three survey questions for each journey, morning and evening. Participation days can be consecutive days or over a period until the end of the programme.
ii. The study invite was redesigned and made concise with a website set up to include additional information and step-by-step procedures for participation.
iii. A section was added in the app to explaining the various steps involved for participation in the study and the rewards at each stage.
iv. All BetterPoints earned for various activities completed were doubled.
v. Every participant who records at least 3 days of activities/surveys on the app would be awarded 10,000 BetterPoints worth £10 within 10 days of the end of the programme instead of the weekly and monthly raffle draws initially adopted.

vi. A new 'Refer a Friend' incentive was added to the study which awards both the participant the referred friend 250 BetterPoints each when the friend registers (and this bonus was available for up to 5 friends referred).

Furthermore, more publicity and reaching out was also adopted in order to recruit participants to the study. Transport for Wales (with a cohort of 5,000 people) were contacted, and they agreed to help with the recruitment exercise by sending out the invites to their cohorts. Social media travel groups were contacted, and the adverts posted on their pages. Flyer and leaflet distribution around the city centre, places hosting large amount of people (such as the stadium, cinemas, and event centres) and major transport hubs/stations were conducted. In addition, attempts were made to go on the local radio stations and television to increase public awareness about the study, but these media houses never agreed to offer support. Eventually, the response number was able to be raised by 74 participants at the end of the 10-week period. In sum, for the 16 weeks the WELCOM study was live, a total of 116 respondents participated in it.

At this juncture, it is important to reflect on the lessons learned from the pilot survey and how this was carried forward into the main study survey exercise. The pilot survey could be lauded as successful especially in relation to the effective functioning of the travel survey instruments employed (i.e., the BetterPoints app and the online questionnaire). Numerous bugs and glitches that affected the proper functioning of the app and web questionnaire were resolved. And most importantly, verbosity in the language of the survey was identified and rectified in order that the survey is perfectly clear about what is required of the participants. However, it would have been appreciated if this success was also replicated in the aspect of sample recruitment. As discussed earlier, the target sample size for the study was not achieved even after the initial sample size was trimmed because of the experiences from the pilot survey. In all, it is not an easy task understanding what could have been improved especially as many of the suggestions from related studies were observed. Perhaps, this is an example that one solution does not fit all situations and solutions to issues should be proffered in relation to their context and locality.

Moreover, the small sample size of the study could also be viewed from a different perspective. Remember that this research was initially conceived as a proof-of-concept study demonstrating the novelty, complexity and multi-dimensionality of the data collection process – all of which have been extensively discussed in this chapter. Furthermore, because of these complexities it would not have been easy for the participants to complete the different layers of the survey to a satisfactory level. Even after recognising these complexities and appropriate

adjustments were made to the survey, it is understood that asking participants for several days' worth of travel information and completing related questionnaires may have been a little too much to ask. Perhaps, this study would have worked better as a cohort study type whereby the participants know exactly what they are signing up for, and what is required of them for that time-period. Eventually, having carefully implemented suggestions from related studies on increasing smartphone-based travel survey participants and these all came up short, it may be concluded that this research might have just experienced some tough luck during the survey exercise. Asides from the aforementioned, evidence has shown that the low acceptance and participation rates of respondents generally undermine the widespread use of smartphone-based travel survey instruments (Susilo et al. 2017). People are generally apprehensive about giving out their information especially when some form of monitoring is involved. This issue is exacerbated because of data privacy and data protection concerns related to installing an application that track mobility on their smartphone devices. The case of Rome and Coventry in the METPEX project are examples illustrating this problem where 0 and 6 respondents respectively opted to download and use the smartphone application developed for the study despite the large-scale advertisement and incentives offered (Susilo et al. 2015; Susilo et al. 2017). Ultimately, this small sample size affected the overall representativeness of the study sample ensuring that the researcher was always cautious when reporting findings from the study especially in relation to making assumptions about the general population from these findings.

3.4.8 Ethics

Prior to the data collection phase, all aspects of this study were approved by the School's Research Ethics Committee (see appendix V for the ethics approval form). The data collection company, BetterPoints were in compliance with the new General Data Protection Regulation (GDPR) and Data Protection Bill that took effect from 25 May 2018 as well as being in compliance with the Data Protection Act (1998). During the entire course of this research, all ethical codes of conduct were strictly adhered to. As VanWey et al. (2005) explained, a major limitation of mobile device localization studies is the difficulty in maintaining anonymity when the data is linked to socio-demographic information especially if the goal is to eventually make the study public. As this study would require the sharing of some sensitive information (especially since the app would track respondents' travel), all data collected were treated with utmost anonymity and confidentiality. Also, they were not shared with any party without the consent of the respondents and even if data would be shared, it would only be as aggregated information. All primary data from the app including commuting patterns and survey data were stored, managed and handled by BetterPoints on secured servers that were encrypted. The

respondents were asked to provide their email addresses which were used to link their entries from the Qualtrics Online Survey platform with their data from BetterPoints. Furthermore, these email addresses were also used to contact selected respondents on their experience with the survey and their general commute pattern. All data provided to the researcher by BetterPoints were stored as per Cardiff University's practises ensuring that the data are safely stored and only accessed by the researcher. Finally, respondents were free to request that their data be deleted and not included in the analysis at any time of the study – of which no one requested. All of these were carefully explained to the respondents during the activation stage of the study before their informed consent was obtained. This informed consent was a form the respondents were obligated to read and consent to or otherwise before they can participate in the survey.

3.4.9 Secondary Data Used

Secondary data sources were used to complement the primary data collected during this study. These sources include data from the Office for National Statistics (ONS) on some variables being measured especially on the indices of deprivation, data from reports from the Department of Transport and the Cardiff City Region Exchange on other socio-demographic information, travel information, commute pattern and information on transport services & infrastructure and the city profile.

3.5 Analytical Framework

This section provides an overview of the methods used for the analysis which is further explored in the analysis chapter. Similar research into the nature of travel and well-being have employed a quantitative approach to analysing the data collected (Abou-Zeid 2009; Ettema et al. 2011; Olsson et al. 2013; Chng et al. 2016; Ye and Titheridge 2019). A multivariate analysis approach was used in this study, and it is consistent with the analysis used in similar studies. A detailed review of the methodology approach used by similar studies can be found in appendix II of the appendix section attached to the end of the thesis. The inferential statistics section of the analysis was divided into four parts to facilitate better understanding of the concepts being discussed. These parts were dimensions of travel satisfaction, well-being, commuting behaviour and mood.

To start with, a correlation analysis explored the relationship between travel satisfaction and well-being. More specifically, the Spearman’s rank correlation was used here because both measures were categorical in nature (Bryman 2016; McCarroll 2016). The study then explored

how the individual's travel satisfaction changes across the various commute modes used. An ordered logistic regression with the dependent variable travel satisfaction and commute mode as the independent variable was employed here. This was used instead of linear regression because the dependent variable is a categorical scale variable (Bryman 2016; Zhu and Fan 2018). Subsequently, the effects of commute distance and commute time on travel satisfaction was explored, albeit in two separate models to avoid collinearity – non-independence of the independent variables (Dormann et al. 2013). As before, an ordered logistic regression model was used because the response variable, travel satisfaction, is ordinal in nature. Lastly, the relationship that exist between travel satisfaction and the socio-demographic characteristics of the respondents were explored using a multilevel logistic regression model. The multilevel logistic regression was employed here instead of the ordered logistics regression because the repeated measures for respondents' activities provides an interdependence problem (another collinearity issue) (Bressoux 2010).

For the dimensions of well-being, similar set of analyses and models to the travel satisfaction models were employed. The only difference was that the dependent variable was well-being instead of travel satisfaction but with similar independent variables. Regarding the dimensions for commuting behaviour, correlation analyses were adopted to explore the relationships across commuting behaviour, travel satisfaction, well-being and neighbourhood quality.

The mood analyses basically explore the spill-over effect commuting has on the individual at three different time intervals: before their commute (mood I), immediately after their commute (mood II) and 90 minutes after their commute (mood III). For each mood, the two categories of valence and activation were analysed using an independent samples t-test to determine if there was a significant difference between the means (Bryman 2016). These means were then compared with each other to determine the spill-over effects.

In term of descriptive statistics employed in the study, the socio-demographic characteristics, commute patterns / behaviours, and access to basic amenities, a good neighbourhood, and urban transportation infrastructure of respondents were analysed using measures of central tendencies to measure the magnitude, probability, and/or extent of occurrence i.e., frequency and percentages where appropriate to better understand any nuance within the population (Bryman 2016).

3.6 Summary

The main purpose of the chapter is to provide an overview of the research design and methodology. An overview of selected empirical research into commuting, travel satisfaction and well-being (including methods adopted) is also provided which form the basis for the methods adopted in this research. The research design in this study was introduced in detail, including the discussion of different research variables that were measured, and the methods adopted in collecting this information. The sampling method adopted was purposive due to the nature of the survey exercise and the availability of respondents. A pilot phase was conducted before the main data collection phase to enable the researcher to test the data collection instruments being adopted. Although the response rates for both the pilot and main survey phases were low, it offers the opportunity for the researcher to learn and make sure that subsequent data collection for similar future studies turns out better.

CHAPTER 4: ANALYSIS AND RESULTS PRESENTATION

4.1 Introduction

At the end of the WELCOM study survey exercise, the total number of registered participants was 116. However due to the unique nature of the data collection process, these number did not equate to the total number of responses obtained.

To start with, the invite sent out to prospective participants had a download link for the BetterPoints app. Once downloaded the participant registers to the study by following the detailed set of instructions given to them. Afterwards, the app directs participants to complete an initial survey hosted on an online survey platform (Qualtrics) where the participants are asked questions relating to their socio-demographic characteristics, attitudes and commuting pattern amongst others. Therefore, two datasets are generated on two separate platforms for the study. These two sets of data would then be merged using a unique identifier common to both datasets.

4.2 Data Preparation

During the data preparation and cleaning stage, it was discovered that not all participants that downloaded the app and registered, completed the initial survey hosted on Qualtrics. To rectify this, the unique identifier was matched to the registered email address for each entry and a list containing unmatching data generated. Over the coming weeks, weekly reminders were sent out individually to the registered email addresses that had not completed the survey but supplied travel and well-being data on the app. As with surveys of these nature, not everyone responded even after being contacted and the study had to use the available data for analysis.

The next stage was to merge the two datasets to determine the total number of participants who had both recorded activity data on the BetterPoints app and completed the initial survey hosted on Qualtrics using the unique identifier. Since this merged data would form the basis of analysis conducted in this study it had to be cleaned manually. This included removing all entries by participants less than 18 years old, removing all entries with distance more than a 100km, and removing all entries with travel time greater than 3hrs. The reasoning behind these decisions were the survey specifically wanted adults aged 18 and over and commute distances and travel times over 100km and 3hrs respectively would be very unrealistic in real world terms within the study area. The resultant dataset consisted of 72 participants who recorded 1,287 observations. Table 4.1 presents the summary statistics for the 72 participants

based on the travel mode used.

Table 4.1: Descriptive Statistics for Selected Activities per mode

Total Observations

Variables	Obs	Mean	Std.Dev.	Min	Max
Age	*	40.55	8.55	23	54
Distance (km)	1287	5.16	4.59	0.87	13.99
Duration (mins)	1287	24.11	12.32	4.61	115.78

Bus

Variables	Obs	Mean	Std.Dev.	Min	Max
Age	*	42.07	8.99	23	54
Distance (km)	198	5.83	1.84	0.88	13.99
Duration (mins)	198	28.99	10.34	4.61	61.55

Car

Variables	Obs	Mean	Std.Dev.	Min	Max
Age	*	42.19	8.04	23	54
Distance (km)	133	8.48	5.39	0.87	34.05
Duration (mins)	133	23.51	13.18	4.58	69.25

Cycle

Variables	Obs	Mean	Std.Dev.	Min	Max
Age	*	40.59	8.04	25	53
Distance (km)	383	4.16	2.85	1.26	11.78
Duration (mins)	383	20.56	13.68	4.43	106.28

Train

Variables	Obs	Mean	Std.Dev.	Min	Max
Age	*	39.63	8.33	26	52
Distance (km)	177	10.78	6.79	3.23	52.77
Duration (mins)	177	21.25	11.45	0.81	61.67

Walk

Variables	Obs	Mean	Std.Dev.	Min	Max
Age	*	39.60	8.91	23	54
Distance (km)	396	2.16	0.76	1.88	9.02
Duration (mins)	396	26.59	10.45	10.45	115.78

Gender Differentials on Travel Mode Used

Gender	Bus (15.37%)	Car (10.33%)	Cycle (29.81%)	Train (13.74%)	Walk (30.75%)	Total (100%)
Female	194 (97.98)	123 (92.48)	215 (56.25)	173 (97.74)	143 (36.11)	848 (65.92)
Male	4 (2.02)	10 (7.52)	168 (43.75)	4 (2.26)	253 (63.89)	439 (34.08)
Total	198 (100)	133 (100)	383 (100)	177 (100)	396 (100)	1287 (100)

** Observations for age not necessary here.*

Source: Author's Survey

Findings from the study show that across all the travel modes, the average age of respondents was 40 years old. Except for observations where the preferred travel mode to work was by walking, women were most represented as per travel modes used. In fact, observations from women represented almost 66% of the study sample. This might be indicative that women almost twice more likely to try out novel ideas and this was further reflected with the number of respondents who replied to the weekly reminders.

Active commuters represented the largest share of commuters in the study area accounting for almost 61% of travel activities recorded. On average, train commuters travelled the longest distance (about 11kms), while both cycle and train commuters travelled to work in the shortest time (in about 21 mins). Perhaps the fact that active commuters travel the shortest distance on average (2kms and 4kms respectively for walking and cycling) should be expected, while bus passengers travelled for the longest time on average (about 29 mins) – which may/may not include multiple transfers or interchanges.

While car commuters have the second longest commute on average (about 9kms), they also do have journey times similar to the sample average at about 24 mins. The average travel distance for work within the study of 5kms was surpassed by the averages for both public transport services (bus and train), and car journeys. This might be indicative of residential location preferences (forced or deliberate) within the study area – this is explored further later.

Finally, both public transport services offered the best and worst journey times on average in the study. Train commuters see the best journey time at about 21 mins while bus commuters experienced the worst times at 29 mins. Several factors could contribute to this including the quality of existing public transport infrastructure and congestion during peak times amongst others, but this perhaps illustrates the challenges of public transportation in cities generally.

4.3 Descriptive Analysis

4.3.1 Socio-Demographic Characteristics

Table 4.2: Socio-Demographic Information

Gender

Gender	Freq.	Percent	Cum.
Female	48	66.67	66.67
Male	24	33.33	100.00
Total	72	100.00	

Age

Age Group	Freq.	Percent	Cum.
Less than 30	14	19.44	19.44
30 - 35	13	18.06	37.50
36 - 39	14	19.44	56.94
40 - 45	13	18.06	75.00
46 - 49	7	9.72	84.72
50 and above	11	15.28	100.00
Total	72	100.00	

Household Type

Household Type	Freq.	Percent	Cum.
Single household without children	16	22.22	22.22
Single household with children	5	6.94	29.17
Couple with children	30	41.67	70.83

Couple without children	21	29.17	100.00
Total	72	100.00	

Number of People in Household

People in Household	Freq.	Percent	Cum.
1	11	15.28	15.28
2	21	29.17	44.44
3	14	19.44	63.89
4	23	31.94	95.83
5	3	4.17	100.00
Total	72	100.00	

Annual Income

Income	Freq.	Percent	Cum.
Less than £20,000	5	7.04	7.04
£20,000-£36,399	15	21.13	28.17
£36,400-£51,999	22	30.99	59.15
£52,000-£77,999	14	19.72	78.87
£78,000 and above	5	7.04	85.92
I prefer not to say	10	14.08	100.00
Total	72	100.00	

Level of Education

Education	Freq.	Percent	Cum.
GCSEs (D-G) NVQ L1	1	1.39	1.39
GCSEs (A-C) NVQ L2	5	6.94	8.33
A Levels (including BTEC Nationals) NVQ L3	8	11.11	19.44
HNC/HND/Foundation Degree NVQ L4	1	1.39	20.83
Bachelor's Degree Years 1 & 2/Other Professional Degree NVQ L5	2	2.78	23.61
Bachelor's (Honours) Degree NVQ L6	26	36.11	59.72
Master's Degree (MSc, MA, MBA, LLM) NVQ L7	19	26.39	86.11
Doctoral Degree (PhD) NVQ L8	10	13.89	100.00
Total	72	100.00	

Employment Status

Employment	Freq.	Percent	Cum.
Full-time	55	76.39	76.39
Part-time	10	13.89	90.28
Non-employed student	5	6.94	97.22
Unemployed	2	2.78	100.00
Total	72	100.00	

Occupational Category

Occupational Category	Freq.	Percent	Cum.
Sales	1	1.39	1.39
Manager/Administrator	9	12.50	13.89
Clerical/Administrative Support	13	18.06	31.94
Professional/Technical	28	38.89	70.83
Government/Civil Service	10	13.89	84.72
Other	11	15.28	100.00
Total	72	100.00	

Ethnicity

Ethnicity	Freq.	Percent	Cum.
White Welsh / English / Scottish / Northern Irish / British	54	75.00	75.00
Any other White background	10	13.89	88.89
Black/African/Caribbean/Black British African	1	1.39	90.28
Asian/Asian British Indian	1	1.39	91.67
Asian/Asian British Pakistani	1	1.39	93.06
Asian/Asian British Chinese	1	1.39	94.44
Any other Asian background	1	1.39	95.83
Any other ethnic group not listed above	3	4.17	100.00
Total	72	100.00	

Work Hours per Week

Weekly Work Hours Group	Freq.	Percent	Cum.
Less than 20hrs	5	6.94	6.94
20 – 35hrs	43	59.72	66.67
over 35hrs	24	33.33	100.00
Total	72	100.00	

Number of Cars in the Household

Cars in Household	Freq.	Percent	Cum.
0	17	23.61	23.61
1	31	43.06	66.67
2	21	29.17	95.83
3	3	4.17	100.00
Total	72	100.00	

Possession of Weekly or Monthly Travel Card

Travel Card	Freq.	Percent	Cum.
Yes	23	31.94	31.94
No	49	68.06	100.00
Total	72	100.00	

Commute Impact

Commute Impact	Freq.	Percent	Cum.
A great deal	13	18.06	18.06
A lot	12	16.67	34.72
A moderate amount	24	33.33	68.06
A little	21	29.17	97.22
None at all	2	2.78	100.00
Total	72	100.00	

Source: Author's Survey

Table 4.2 presents the descriptive statistics for socio-demographics within the study sample. Although the average age of respondents across all the travel mode was 40 years old, it is observed that 75% of respondents were 45 years old or younger and the majority were female. Regarding childcare responsibilities, the sample is almost evenly distributed as suggested by respondents without childcare responsibilities narrowly edging out those with childcare responsibilities at 51% and 49% respectively. Generally, household types listed as couples with children are the most prevalent at 42% while single-parent households are the least at 5%. In terms of number of people living in the household, households with between 1 and 4 people represent the majority at 96%. Although households of 2 and 4 people are the most prevalent at 29% and 32% respectively indicative of a prevalence of a more nuclear family structure within the sample.

A large proportion of respondents surveyed (about 31%) earn between £36,400 - £51,999 yearly. This is not far off from the UK national average of £35,423 (ONS 2020). And 60% of the respondents sampled were educated up to the tertiary education level. If this is further broken down, 36% of the tertiary educated respondents hold at least a bachelor's degree. As explained earlier in the methodology chapter, the peculiarities of this study necessitated that many the respondents would have a university degree.

Furthermore, about 90% of respondents said they were in either full or part time employment as compared to only 3% that were unemployed. Again, the research requirement was the reason for this since a purposive sampling technique was employed in respondent selection. As regards occupational category, 39% of the respondents said they worked a professional or technical job representing the largest proportion. This is followed by respondents that worked as clerical or administrative support at 18%. Also, about 93% of the respondents worked full-time jobs with almost 33% saying they worked over 35hrs weekly (working overtime).

Ethnicity-wise, respondents were predominantly white with respondents from Black, Asian, and other ethnic background accounting for only about 11%. When compared to the national average, minority ethnic groups represents only 4% of the general population (ONS 2012).
As regards car ownership, about 24% of respondents do not own vehicles in their household. Considering that over 60% of respondents commute via active travel modes, it might have been expected that the number of respondents without vehicles in their household would be more. Interestingly, only about 10% of commutes were car journeys but almost 67% of the respondents have at least 1 car in their household. Several factors could be the reason for this amongst which are a presumed change in orientation to car usage, distance to workplace and lifestyle change amongst others. Finally, about 32% of respondents surveyed have a weekly or monthly travel card. Considering that 29% of journeys in the survey were undertaken by public transportation (bus and train), these figures are within reason.

4.3.2 Neighbourhood Quality Perceptions

Table 4.3: Neighbourhood Quality

Neighbourhood road quality	Freq.	Percent	Cum.
Extremely dissatisfied	3	4.17	4.17
Moderately dissatisfied	12	16.67	20.83
Slightly dissatisfied	17	23.61	44.44
Neither satisfied nor dissatisfied	5	6.94	51.39
Slightly satisfied	14	19.44	70.83
Moderately satisfied	15	20.83	91.67
Extremely satisfied	6	8.33	100.00
Total	72	100.00	
Neighbourhood parking spaces	Freq.	Percent	Cum.
Extremely dissatisfied	4	5.56	5.56
Moderately dissatisfied	10	13.89	19.44
Slightly dissatisfied	14	19.44	38.89
Neither satisfied nor dissatisfied	10	13.89	52.78
Slightly satisfied	13	18.06	70.83
Moderately satisfied	11	15.28	86.11
Extremely satisfied	10	13.89	100.00
Total	72	100.00	
Neighbourhood public transport condition	Freq.	Percent	Cum.
Extremely dissatisfied	4	5.56	5.56
Moderately dissatisfied	9	12.50	18.06
Slightly dissatisfied	8	11.11	29.17

Neither satisfied nor dissatisfied	15	20.83	50.00
Slightly satisfied	7	9.72	59.72
Moderately satisfied	24	33.33	93.06
Extremely satisfied	5	6.94	100.00
Total	72	100.00	
Neighbourhood accessibility to a GP or dentist	Freq.	Percent	Cum.
Extremely dissatisfied	2	2.78	2.78
Moderately dissatisfied	4	5.56	8.33
Slightly dissatisfied	9	12.50	20.83
Neither satisfied nor dissatisfied	9	12.50	33.33
Slightly satisfied	10	13.89	47.22
Moderately satisfied	20	27.78	75.00
Extremely satisfied	18	25.00	100.00
Total	72	100.00	
Neighbourhood accessibility to a park, or a safe place to relax or exercise	Freq.	Percent	Cum.
Moderately dissatisfied	5	6.94	6.94
Slightly dissatisfied	4	5.56	12.50
Neither satisfied nor dissatisfied	8	11.11	23.61
Slightly satisfied	15	20.83	44.44
Moderately satisfied	15	20.83	65.28
Extremely satisfied	25	34.72	100.00
Total	72	100.00	
Neighbourhood accessibility to convenience stores	Freq.	Percent	Cum.
Extremely dissatisfied	2	2.78	2.78
Moderately dissatisfied	2	2.78	5.56
Slightly dissatisfied	3	4.17	9.72
Neither satisfied nor dissatisfied	2	2.78	12.50
Slightly satisfied	12	16.67	29.17
Moderately satisfied	18	25.00	54.17
Extremely satisfied	33	45.83	100.00
Total	72	100.00	
Neighbourhood street lighting condition	Freq.	Percent	Cum.
Extremely dissatisfied	1	1.39	1.39
Moderately dissatisfied	3	4.17	5.56
Slightly dissatisfied	7	9.72	15.28
Neither satisfied nor dissatisfied	11	15.28	30.56
Slightly satisfied	10	13.89	44.44
Moderately satisfied	22	30.56	75.00
Extremely satisfied	18	25.00	100.00
Total	72	100.00	
Neighbourhood state of security	Freq.	Percent	Cum.
Extremely dissatisfied	1	1.39	1.39
Moderately dissatisfied	5	6.94	8.33
Slightly dissatisfied	5	6.94	15.28
Neither satisfied nor dissatisfied	6	8.33	23.61
Slightly satisfied	16	22.22	45.83
Moderately satisfied	27	37.50	83.33
Extremely satisfied	12	16.67	100.00
Total	72	100.00	
Overall Neighbourhood satisfaction	Freq.	Percent	Cum.
Moderately dissatisfied	1	1.39	1.39
Slightly dissatisfied	5	6.94	8.33
Neither satisfied nor dissatisfied	4	5.56	13.89
Slightly satisfied	16	22.22	36.11
Moderately satisfied	32	44.44	80.56
Extremely satisfied	14	19.44	100.00
Total	72	100.00	

How long have you lived in this neighbourhood (in years)?	Freq.	Percent	Cum.
Less than 1	8	11.11	11.11
1 - 5	30	41.67	52.78
6 - 9	12	16.67	69.44
10 -15	10	13.89	83.33
16 - 19	5	6.94	90.28
20 - 25	6	8.33	98.61
26 and above	1	1.39	100.00
Total	72	100.00	
Did the availability of a car determine your choice of moving to this neighbourhood?	Freq.	Percent	Cum.
Yes	21	29.17	29.17
No	51	70.83	100.00
Total	72	100.00	

Source: Author's Survey

This subsection presents the participants' neighbourhood perception. A summary of some information that stand out is presented in Table 4.3. Since public transport respondents experienced the best and worst journey times, it was not surprising to see that half of the respondents indicated they were satisfied with their neighbourhood public transport condition as against 29% that were dissatisfied. Interestingly, none of the respondent sampled were extremely dissatisfied with their access to neighbourhood public spaces. Also, almost half of the respondents sampled were extremely satisfied with their access to convenience stores within their neighbourhood with less than 10% indicating they were dissatisfied in any way. When asked about their overall satisfaction with the neighbourhood they live in, 86% of respondents were satisfied with only about 8% dissatisfied. Also, none of the respondents sampled were extremely dissatisfied with the overall condition of their neighbourhood. Furthermore, many respondents (about 42%) in the study have lived in their neighbourhood for between 1 and 5 years. In fact, almost 83% of respondents have lived in their neighbourhood for less than 15 years compared with the 17% that have lived in their neighbourhood for more than 15 years. Considering the average age of the study sample and the household characteristics, this figure is seemingly correct.

4.3.3 Commuting Behaviour and Attitudes

Table 4.4: Commuting Behaviour and Attitude

Commuting is boring	Freq.	Percent	Cum.
Strongly disagree	3	4.17	4.17
Disagree	6	8.33	12.50
Somewhat disagree	13	18.06	30.56
Neither agree nor disagree	17	23.61	54.17
Somewhat agree	19	26.39	80.56
Agree	12	16.67	97.22
Strongly agree	2	2.78	100.00
Total	72	100.00	

Commuting makes me nervous	Freq.	Percent	Cum.
Strongly disagree	8	11.11	11.11
Disagree	20	27.78	38.89
Somewhat disagree	7	9.72	48.61
Neither agree nor disagree	12	16.67	65.28
Somewhat agree	17	23.61	88.89
Agree	4	5.56	94.44
Strongly agree	4	5.56	100.00
Total	72	100.00	

I often worry about my safety when I commute	Freq.	Percent	Cum.
Strongly disagree	6	8.33	8.33
Disagree	25	34.72	43.06
Somewhat disagree	10	13.89	56.94
Neither agree nor disagree	10	13.89	70.83
Somewhat agree	15	20.83	91.67
Agree	5	6.94	98.61
Strongly agree	1	1.39	100.00
Total	72	100.00	

My commute is a useful transition between home and work (and vice versa)	Freq.	Percent	Cum.
Strongly disagree	3	4.17	4.17
Disagree	2	2.78	6.94
Somewhat disagree	4	5.56	12.50
Neither agree nor disagree	13	18.06	30.56
Somewhat agree	22	30.56	61.11
Agree	23	31.94	93.06
Strongly agree	5	6.94	100.00
Total	72	100.00	

I am uncomfortable being around people I do not know when I commute	Freq.	Percent	Cum.
Strongly disagree	7	9.72	9.72
Disagree	20	27.78	37.50
Somewhat disagree	10	13.89	51.39
Neither agree nor disagree	16	22.22	73.61
Somewhat agree	12	16.67	90.28
Agree	5	6.94	97.22
Strongly agree	2	2.78	100.00
Total	72	100.00	

Having to wait makes me feel like I am wasting my time	Freq.	Percent	Cum.
Disagree	4	5.56	5.56
Somewhat disagree	3	4.17	9.72
Neither agree nor disagree	6	8.33	18.06
Somewhat agree	24	33.33	51.39
Agree	25	34.72	86.11
Strongly agree	10	13.89	100.00
Total	72	100.00	

We need more public transportation even if it means I pay more in taxes	Freq.	Percent	Cum.
Strongly disagree	1	1.39	1.39
Disagree	5	6.94	8.33
Somewhat disagree	6	8.33	16.67
Neither agree nor disagree	13	18.06	34.72
Somewhat agree	20	27.78	62.50
Agree	18	25.00	87.50
Strongly agree	9	12.50	100.00

Total	72	100.00	
A car is nothing more than a convenient way to get around	Freq.	Percent	Cum.
Disagree	7	9.72	9.72
Somewhat disagree	6	8.33	18.06
Neither agree nor disagree	3	4.17	22.22
Somewhat agree	21	29.17	51.39
Agree	26	36.11	87.50
Strongly agree	9	12.50	100.00
Total	72	100.00	
For improved environmental quality and sustainability, I am willing to limit auto-travel and/or pay extra to use electric or clean-fuel vehicles	Freq.	Percent	Cum.
Strongly disagree	2	2.78	2.78
Disagree	2	2.78	5.56
Somewhat disagree	1	1.39	6.94
Neither agree nor disagree	15	20.83	27.78
Somewhat agree	11	15.28	43.06
Agree	24	33.33	76.39
Strongly agree	17	23.61	100.00
Total	72	100.00	
I would like to spend some time each week on myself	Freq.	Percent	Cum.
Neither agree nor disagree	1	1.39	1.39
Somewhat agree	11	15.28	16.67
Agree	36	50.00	66.67
Strongly agree	24	33.33	100.00
Total	72	100.00	
I would like to spend more time on work	Freq.	Percent	Cum.
Strongly disagree	12	16.67	16.67
Disagree	23	31.94	48.61
Somewhat disagree	22	30.56	79.17
Neither agree nor disagree	6	8.33	87.50
Somewhat agree	2	2.78	90.28
Agree	6	8.33	98.61
Strongly agree	1	1.39	100.00
Total	72	100.00	
I would like to spend more time with family and friends	Freq.	Percent	Cum.
Somewhat disagree	2	2.78	2.78
Neither agree nor disagree	4	5.56	8.33
Somewhat agree	15	20.83	29.17
Agree	27	37.50	66.67
Strongly agree	24	33.33	100.00
Total	72	100.00	
I would like to spend more time on environmental, social, religious or voluntary causes	Freq.	Percent	Cum.
Strongly disagree	2	2.78	2.78
Disagree	4	5.56	8.33
Somewhat disagree	6	8.33	16.67
Neither agree nor disagree	12	16.67	33.33
Somewhat agree	22	30.56	63.89
Agree	19	26.39	90.28
Strongly agree	7	9.72	100.00
Total	72	100.00	

Source: Author's Survey

The respondents were asked some questions to determine their attitudes and behaviour towards commuting. A summary of the findings is presented in Table 4.4. Regarding public

transport use, more than half of the respondents sampled (51%) are quite comfortable being around people they do not know when they commute compared to the 26% who feel uncomfortable around others when they travel. 69% of the respondents agree that their commute served as a useful transition between the homes and workplace (and vice versa), while 13% disagree. Similarly, 82% of the respondents feel that having to wait for public transportation amounts to time wasted as compared to the 10% who do not share this belief. Interestingly, 65% of the respondents said that they would be willing to pay more in taxes if it would improve public transport services and facilities, compared to the 17% who do not share that belief. Furthermore, majority of the respondents (72%) said that they would be willing to adopt more environmentally conscious travel modes even as far as paying extra to use electric vehicles where possible while about 7% disagreed.

4.3.4 Beliefs about Well-being

Table 4.5: Beliefs about Well-being

A great amount of pleasure	Freq.	Percent	Cum.
Strongly disagree	1	1.39	1.39
Disagree	1	1.39	2.78
Somewhat disagree	3	4.17	6.94
Neither agree nor disagree	5	6.94	13.89
Somewhat agree	26	36.11	50.00
Agree	25	34.72	84.72
Strongly agree	11	15.28	100.00
Total	72	100.00	
Pleasurable experiences	Freq.	Percent	Cum.
Somewhat disagree	3	4.17	4.17
Neither agree nor disagree	1	1.39	5.56
Somewhat agree	18	25.00	30.56
Agree	34	47.22	77.78
Strongly agree	16	22.22	100.00
Total	72	100.00	
Experiencing euphoria and pleasure	Freq.	Percent	Cum.
Disagree	2	2.78	2.78
Somewhat disagree	5	6.94	9.72
Neither agree nor disagree	13	18.06	27.78
Somewhat agree	22	30.56	58.33
Agree	20	27.78	86.11
Strongly agree	10	13.89	100.00
Total	72	100.00	
Experiencing a great deal of sensual pleasure	Freq.	Percent	Cum.
Disagree	3	4.17	4.17
Somewhat disagree	3	4.17	8.33
Neither agree nor disagree	19	26.39	34.72
Somewhat agree	23	31.94	66.67
Agree	16	22.22	88.89
Strongly agree	8	11.11	100.00
Total	72	100.00	
A lack of unpleasant experiences	Freq.	Percent	Cum.
Disagree	4	5.56	5.56
Somewhat disagree	12	16.67	22.22
Neither agree nor disagree	8	11.11	33.33

Somewhat agree	19	26.39	59.72
Agree	22	30.56	90.28
Strongly agree	7	9.72	100.00
Total	72	100.00	
A lack of painful experiences	Freq.	Percent	Cum.
Strongly disagree	2	2.78	2.78
Disagree	2	2.78	5.56
Somewhat disagree	10	13.89	19.44
Neither agree nor disagree	11	15.28	34.72
Somewhat agree	14	19.44	54.17
Agree	19	26.39	80.56
Strongly agree	14	19.44	100.00
Total	72	100.00	
Not experiencing negative emotions	Freq.	Percent	Cum.
Strongly disagree	2	2.78	2.78
Disagree	2	2.78	5.56
Somewhat disagree	15	20.83	26.39
Neither agree nor disagree	10	13.89	40.28
Somewhat agree	15	20.83	61.11
Agree	20	27.78	88.89
Strongly agree	8	11.11	100.00
Total	72	100.00	
Not experiencing hassles	Freq.	Percent	Cum.
Strongly disagree	1	1.39	1.39
Disagree	3	4.17	5.56
Somewhat disagree	9	12.50	18.06
Neither agree nor disagree	10	13.89	31.94
Somewhat agree	22	30.56	62.50
Agree	23	31.94	94.44
Strongly agree	4	5.56	100.00
Total		72	100.00
Living in ways that benefit others	Freq.	Percent	Cum.
Somewhat disagree	1	1.39	1.39
Neither agree nor disagree	4	5.56	6.94
Somewhat agree	24	33.33	40.28
Agree	30	41.67	81.94
Strongly agree	13	18.06	100.00
Total	72	100.00	
Making the world a better place	Freq.	Percent	Cum.
Somewhat disagree	1	1.39	1.39
Neither agree nor disagree	3	4.17	5.56
Somewhat agree	16	22.22	27.78
Agree	32	44.44	72.22
Strongly agree	20	27.78	100.00
Total	72	100.00	
Being a positive influence within the community	Freq.	Percent	Cum.
Neither agree nor disagree	10	13.89	13.89
Somewhat agree	13	18.06	31.94
Agree	30	41.67	73.61
Strongly agree	19	26.39	100.00
Total	72	100.00	
Contribution to society	Freq.	Percent	Cum.
Neither agree nor disagree	4	5.56	5.56
Somewhat agree	18	25.00	30.56
Agree	35	48.61	79.17
Strongly agree	15	20.83	100.00
Total	72	100.00	
Working to achieve one's true potential	Freq.	Percent	Cum.
Somewhat disagree	1	1.39	1.39

Neither agree nor disagree	7	9.72	11.11
Somewhat agree	12	16.67	27.78
Agree	36	50.00	77.78
Strongly agree	16	22.22	100.00
Total	72	100.00	
The identification and cultivation of one's strengths	Freq.	Percent	Cum.
Somewhat disagree	1	1.39	1.39
Neither agree nor disagree	4	5.56	6.94
Somewhat agree	19	26.39	33.33
Agree	35	48.61	81.94
Strongly agree	13	18.06	100.00
Total	72	100.00	
The exertion of effort to meet life's challenges	Freq.	Percent	Cum.
Somewhat disagree	3	4.17	4.17
Neither agree nor disagree	13	18.06	22.22
Somewhat agree	20	27.78	50.00
Agree	26	36.11	86.11
Strongly agree	10	13.89	100.00
Total	72	100.00	
A high degree of self-knowledge	Freq.	Percent	Cum.
Somewhat disagree	1	1.22	1.22
Neither agree nor disagree	5	6.10	7.32
Somewhat agree	24	29.27	36.59
Agree	38	46.34	82.93
Strongly agree	14	17.07	100.00
Total	72	100.00	

Source: Author's Survey

The respondents were asked what they assumed the experience of well-being entailed. Table 4.5 above summarises their answers. As regards the hedonistic aspects of well-being – the presence of pleasure/positive emotions and the absence of displeasure/negative emotions, 79% of the respondents generally believed that is what having a good sense of well-being entails. Although none of the respondents disagreed that being a positive influence in one's community is indicative of a good sense of well-being, 14% neither agreed nor disagreed and 86% agreed. Similarly, while none of the respondent disagreed with contributing to the society amounting to living the best version of themselves, 6% neither agreed or disagreed and 94% agreed. In essence, almost all the respondents sampled believed that a good sense of well-being is related to doing good and helping others. Finally, in relation to the eudaimonia aspects of well-being – achievement of ones' true potentials and the betterment of oneself, 88% of respondents believe this to be an indicator of living a life with a great sense of well-being. The remaining eudaimonia characteristics followed a similar pattern, showing an overwhelming agreement to those beliefs by respondents in the sample.

4.3.5 Mood (Valence and Activation) – Pre commute, immediately after commute, and post commute

Table 4.6: Frequency Table for Moods I, II and III

Mood I - Pre-Commute Valence (Unpleasant/Pleasant experience)	Freq.	Percent	Cum.
Very sad	11	0.66	0.66
Depressed	44	2.63	3.29
Displeased	169	10.11	13.40
Neutral	763	45.63	59.03
Pleased	568	33.97	93.00
Very glad	84	5.02	98.03
Joyful	33	1.97	100.00
Total	1,672	100.00	
Mood I - Pre-Commute Activation (Quiet/Excitement experience)	Freq.	Percent	Cum.
Very passive	23	1.38	1.38
Sleepy	227	13.58	14.95
Dull	216	12.92	27.87
Neutral	394	23.56	51.44
Awake	650	38.88	90.31
Lively	134	8.01	98.33
Very active	28	1.67	100.00
Total	1,672	100.00	
Mood II - Journey End Valence (Unpleasant/Pleasant experience)	Freq.	Percent	Cum.
Very sad	7	0.66	0.66
Depressed	21	1.99	2.65
Displeased	87	8.24	10.89
Neutral	350	33.14	44.03
Pleased	509	48.20	92.23
Very glad	71	6.72	98.96
Joyful	11	1.04	100.00
Total	1,056	100.00	
Mood II - Journey End Activation (Quiet/Excitement experience)	Freq.	Percent	Cum.
Very passive	2	0.19	0.19
Sleepy	45	4.26	4.45
Dull	83	7.86	12.31
Neutral	243	23.01	35.32
Awake	522	49.43	84.75
Lively	142	13.45	98.20
Very active	19	1.80	100.00
Total	1,056	100.00	
Mood III - Post-Commute Valence (Unpleasant/Pleasant experience)	Freq.	Percent	Cum.
Very sad	1	0.09	0.09
Depressed	13	1.20	1.29
Displeased	35	3.22	4.51
Neutral	428	39.37	43.88
Pleased	494	45.45	89.33
Very glad	97	8.92	98.25
Joyful	19	1.75	100.00
Total	1,087	100.00	
Mood III - Post-Commute Activation (Quiet/Excitement experience)	Freq.	Percent	Cum.
Very passive	5	0.46	0.46
Sleepy	87	8.00	8.46
Dull	35	3.22	11.68

Neutral	323	29.71	41.40
Awake	518	47.65	89.05
Lively	97	8.92	97.98
Very active	22	2.02	100.00
Total	1,087	100.00	

Source: Author's Survey

The mood data is categorised into three sets – mood I (pre-commute), mood II (immediately after journey end) and mood III (post-commute). As discussed earlier, these readings are recorded at various intervals before and after each journey across several days. Furthermore, these mood readings are subdivided into two categories namely a pleasant/unpleasant experience referred to as valence, and a quiet/excitement experience referred to as activation (Friman et al. 2017b). Table 4.6 presents the summary statistics for the moods and mood changes over the course of data collection.

Mood I – Both valence and activation had a total observation of 1,672 each. In terms of valence mood before commute about 46% of respondents were neutral, neither experiencing a pleasant or unpleasant feeling. About 41% of respondents recorded experiencing varying degrees of having a pleasant feeling while only 13% recorded experiencing a general unpleasant feeling before commute. In terms of activation before commute, almost 49% of respondents reported feeling active with majority feeling awake. About 24% felt neither active or passive and a little over 27% recorded feeling passive with most feeling either dull or sleepy.

Mood II – Observations for both valence and activation moods for this category was taken immediately at the end of the commute. A total of 1,056 observations were recorded for each – valence and activation. It is possible that respondents forgot to record readings at the end of some journeys thus resulting in the reduction in the total observations for these categories. As regards valence mood after commute, about 56% of respondents reported experiencing a pleasant feeling – up by 15% when compared to mood I valence. About 11% of respondents reported experiencing some sort of unpleasant feeling – down by 2% when compared to mood I valence. And 33% reported experiencing neither pleasant nor unpleasant feelings immediately after the journey – also down by 13% when compared to mood I valence. In terms of activation immediately after the commute, about 65% of respondents reported feeling active with the majority feeling awake – this is up by 16% when compared with mood I activation. About 23% of respondents felt neither active nor passive – down by 1% when compared to mood I activation. While about 12% recorded feeling passive with most feeling dull – down by 15% when compared to mood I activation.

Mood III – A total of 1,087 observations were each recorded for valence and activation in this category. As with the observations from mood II, it is possible more respondents forgot to enter readings for this category as it was recorded a little while after their commute, hence the lower number of observations when compared with mood I. In terms of valence mood 90 minutes after the commute, about 56% of respondents reported experiencing a pleasant feeling with majority feeling pleased – up by 15% when compared with mood I valence and on par with mood II valence as no change recorded. About 5% of respondents reported experiencing some form of unpleasant feeling with most feeling displeased – down by 8% and 6% respectively when compared to mood I and II valence. Also, about 39% reported experiencing neither pleasant nor unpleasant feelings 90 mins after the commute – down by 7% when compared to mood I and up by 6% when compared to mood II. Regarding activation 90 minutes after the commute, about 58% of respondents reported feeling active with most feeling awake – up by 9% when compared to mood I and down by 7% when compared to mood II. However, about 30% felt neither active nor passive – up by 6% when compared to mood I and up by 7% when compared to mood II. Lastly, about 12% of respondents reported feeling passive with most feeling sleepy – down by 16% when compared to mood I and no change when compared to mood II.

A more elaborate discussion of the changes in the moods experienced by respondents is presented later in this section.

4.4 Reliability Test

This test is an estimate of internal consistency reliability. It measures the percentage of the variance in the scores of the individual items that make up a whole or how closely related the items that make up a group are (Bryman 2016). In determining the relevance and quality of a measurement scales to a study – especially scales measuring attitudes and affective constructs, the Cronbach alpha has been commonly used to measure reliability (Lance et al. 2006). Moreover, the higher the Cronbach alpha, the higher the reliability value, and the better fit the individual items of the scales are to explain the whole. Also, reliability tends to fluctuate from sample to sample even when the same scale is used, hence there is the need to calculate the internal consistency for every new dataset used.

Generally, the Cronbach alpha takes on a value of between 0.00 and 1.00. The former signifies no consistency in measurement, while the latter signifies perfect consistency in measurement (Gignac 2019). While there is no clear consensus on the acceptable threshold for alpha values, it is believed that between 0.6 and 0.7 are generally acceptable as the lower limit

score, however, lower value scores below this threshold should not necessarily be taken as unsatisfactory (Taber 2018). The Cronbach alpha values of all measurement scales adopted in this study fall within the 'acceptable threshold' for reliability as shown below.

4.4.1 Mood

In this study, mood is categorised into three sets; the mood before commute called mood I (or pre-commute), the mood at the end of the journey called mood II (immediately after journey end) and the mood 90 minutes after the journey end called mood III (or post-commute). As discussed earlier, these readings are recorded at various intervals before and after each journey across the duration of time the respondent was in the study. Each mood reading is subdivided into two categories namely a pleasant/unpleasant experience referred to as valence, and a quiet/excitement experience referred to as activation. These readings were measured by asking the respondents how they felt at that moment and their answers were rated on 7-point Likert scales for the two categories measured. This measurement scale was designed based on the Swedish Core Affect Scale (SCAS) which measures core affects, argued to be instrumental for understanding emotions (Friman et al. 2017b). The negative and positive endpoints of the valence scale were defined by three adjectives *very sad, depressed, displeased,* and *pleased, very glad, joyful*, respectively. While the negative and positive endpoints of the activation scale were defined by *very passive, sleepy, dull*, and *awake, lively, very active*, respectively.

Table 4.7: Moods I, II and III

Item	Average interim covariance	Number of items in the scale	Scale reliability coefficient
Mood I – Pre-Commute	0.63	2	**0.67 (67%)**
Mood II – Immediately After Journey End	0.49	2	**0.69 (69%)**
Mood III – Post-Commute	0.39	2	**0.61 (61%)**

Source: Author's Survey

The reliability of the subscale scores for mood is presented in Table 4.7. For the mood I data, the two categories of valence and activation measured 0.67, indicative that 67% of variance in mood I is reliable variance. Similarly, mood II and mood III valence and activation categories measured 0.69 and 0.61 respectively, suggesting that 69% and 61% of variance in both mood measures are reliable variance as far as the study is concerned.

4.4.2 Travel Satisfaction

As earlier discussed, three categories make up the travel satisfaction scale – the Positive Activation Negative Deactivation (PAND) which measures levels of enthusiasm and boredom; the Positive Deactivation Negative Activation (PDNA) which measures levels of stress and relaxation; and the Cognitive Evaluation (CE) measuring the overall commute experience (Ettema et al. 2011). All of these categories measures both affective and cognitive dimensions of well-being on a 7-point Likert type scale ranging from -3 to 3 (Ettema et al. 2011). Furthermore, since the three categories of the travel satisfaction scale all have three different 7-point Likert scale measurements, travel satisfaction was represented by one 7-point Likert scale measurement when aggregated for analysis purpose. This scale also measured from -3 to 3 denoted as strongly dissatisfied, dissatisfied, somewhat dissatisfied, neither satisfied nor dissatisfied, somewhat satisfied, satisfied, and strongly satisfied.

Table 4.8: Travel Satisfaction – Satisfaction with Travel Scale (STS)

Item	Sign	Item-test correlation	Item-rest correlation	Average interim covariance	Alpha
PAND – Positive Activation Negative Deactivation (Enthusiasm/boredom)	+	0.78	0.51	0.67	**0.77**
PDNA – Positive Deactivation Negative Activation (Stressed/relaxation)	+	0.85	0.61	0.48	**0.66**
CE – Cognitive Evaluation (Overall experience of your journey)	+	0.84	0.67	0.54	**0.61**
Test scale				0.56	**0.76**

Test scale = mean (unstandardized items)
Average interitem covariance: 0.56
Number of items in the scale: 3
Scale reliability coefficient: 0.76 (76%)

Scale	Satisfaction with Travel Scale (STS)			Travel Satisfaction (Label)
	PAND	PDNA	CE	
-3	Very bored	Stressed	Travel was the worst I can think of	Strongly Dissatisfied
-2	Tired	Worried	Travel was of a low standard	Dissatisfied
-1	Fed up	Hurried	Travel did not work out well	Somewhat Dissatisfied
0	Neutral	Neutral	Travel was neither good nor bad	Neither Satisfied nor Dissatisfied
1	Alert	Calm	Travel worked out well	Somewhat Satisfied
2	Engaged	Relaxed	Travel was of a high standard	Satisfied
3	Enthusiastic	Confident	Travel was the best I can think of	Strongly Satisfied

Source: Author's Survey

Table 4.8 above presents the reliability subscale scores for all the categories that make up the travel satisfaction scale, as well as the internal consistency of the scale as a unit of measuring

travel satisfaction. The Cronbach alpha values for each subscale were 0.77, 0.66 and 0.61 respectively for PAND, PDNA, and CE scales. Furthermore, the overall internal consistency value was 0.76, indicative that 76% of variance in the three subscale measures were reliable.

4.4.3 Well-being

The Satisfaction with Life Scale (SWLS) is used to measure subjective well-being during the survey exercise. This scale comprises of 5 statements about well-being answered on a 7-point Likert scale ranging from strongly disagree to strongly agree (Pavot and Diener 1993).

Table 4.9: Well-being – Satisfaction with Life Scale (SWLS)

Item	Sign	Item-test correlation	Item-rest correlation	Average interim covariance	Alpha
In most ways, my life is close to my ideal	+	0.88	0.80	1.33	**0.86**
The conditions of my life are excellent	+	0.88	0.80	1.32	**0.86**
I am satisfied with my life	+	0.87	0.77	1.27	**0.86**
So far, I have gotten the important things I want in life	+	0.75	0.60	1.41	**0.88**
If I could live my life over, I would change almost nothing	+	0.82	0.67	1.29	**0.89**
Test scale				1.33	**0.89**

Test scale = mean (unstandardized items)
Average interitem covariance: 1.33
Number of items in the scale: 5
Scale reliability coefficient: 0.89 (89%)
Source: Author's Survey

Table 4.9 presents the reliability subscale scores for all the categories that make up the SWLS, as well as the internal consistency of the scale as a unit of measuring well-being. The Cronbach alpha values for each subscale were 0.86, 0.86 and 0.86, 0.88, and 0.89 with the overall internal consistency at 0.89. This means that 89% of variance in the 5 subscale measures were reliable.

4.4.4 Commuting Behaviour

The Commuting Behaviour Scale (CBS) is used to measure commuting behaviour in the study. This scale comprises of 13 statements on commuting attitudes and behaviours from the review of literature. The elements of the scale include statements about active, car and public transport commuting. Moreover, statements on sustainable transport use and self-evaluation was also included. This scale is measured on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree" (see appendix IV for the full scale).

Table 4.10: Commuting Behaviour – Commuting Behaviour Scale (CBS)

Item	Sign	Item-test correlation	Item-rest correlation	Average interim covariance	Alpha
Attitude Q1_1	+	0.63	0.46	0.15	**0.57**
Attitude Q1_2	+	0.70	0.55	0.14	**0.55**
Attitude Q1_3	+	0.59	0.45	0.16	**0.58**
Attitude Q1_4	-	0.23	0.07	0.21	**0.64**
Attitude Q2_1	+	0.59	0.44	0.16	**0.58**
Attitude Q2_2	+	0.46	0.28	0.18	**0.61**
Attitude Q2_3	+	0.41	0.20	0.19	**0.63**
Attitude Q3_1	-	0.30	0.13	0.21	**0.64**
Attitude Q3_2	-	0.42	0.28	0.19	**0.61**
Attitude Q4_1	-	0.21	0.10	0.21	**0.63**
Attitude Q4_2	-	0.19	0.05	0.22	**0.64**
Attitude Q4_3	+	0.41	0.29	0.19	**0.61**
Attitude Q4_4	+	0.25	0.09	0.21	**0.64**
Test scale				0.19	**0.63**

Test scale = mean (unstandardized items)
Average interitem covariance: 0.19
Number of items in the scale: 13
Scale reliability coefficient: 0.63 (63%)
Source: Author's Survey

Table 4.10 presents the reliability subscale scores for each of the elements that make up the CBS, as well as the internal consistency of the CBS being used as a measurement for commuting behaviour in the study. The Cronbach alpha values for each subscale ranged from 0.55 to 0.64 with the overall internal consistency at 0.63. This means that 63% of variance in the 13 subscale measures were reliable.

4.4.5 Neighbourhood Quality

The Basic Access, Transport Services and Infrastructure Scale is used to measure neighbourhood quality in the study. This scale comprises of 9 statements rating the accessibility to services, transport infrastructure and a sense of security within the neighbourhood from a review of literature. This scale is measured on a 7-point Likert scale ranging from "extremely dissatisfied" to "extremely satisfied" (see appendix IV for the full scale).

Table 4.11: Basic Access, Transport Services and Infrastructure Scale (BATSIS)

Item	Sign	Item-test correlation	Item-rest correlation	Average interim covariance	Alpha
Access Q1_1	+	0.68	0.54	0.64	**0.79**
Access Q1_2	+	0.51	0.35	0.74	**0.82**
Access Q1_3	+	0.57	0.43	0.71	**0.80**
Access Q2_1	+	0.64	0.49	0.67	**0.80**
Access Q2_2	+	0.58	0.45	0.72	**0.80**
Access Q2_3	+	0.53	0.42	0.75	**0.81**
Access Q3_1	+	0.75	0.66	0.64	**0.78**

Access Q3_2	+	0.77	0.68	0.64	**0.77**
Access Q3_3	+	0.76	0.70	0.69	**0.78**
Test scale				0.69	**0.81**

Test scale = mean (unstandardized items)
Average interitem covariance: 0.69
Number of items in the scale: 9
Scale reliability coefficient: 0.81 (81%)
Source: Author's Survey

Table 4.11 presents the reliability subscale scores for each of the elements that make up the BATSIS, as well as the internal consistency of the BATSIS being used as a measurement for neighbourhood quality in the study. The Cronbach alpha values for each subscale ranged from 0.77 to 0.82 with the overall internal consistency at 0.81. This means that 81% of variance in the 9 subscale measures were reliable.

4.5 Travel Satisfaction and Well-being Over Time

In this section, the travel satisfaction of the respondents was compared to their well-being over time. Instead of having a global comparison of the travel and well-being data, a mode-by-mode type of comparison was done. The purpose of this was to understand any differences in the travel satisfaction and well-being ratings the commute mode might pose.

For each mode, composite scores were calculated for both the travel satisfaction and well-being which were compared over time and presented on a graph. The x-axis is over laid with the scores for both travel satisfaction and well-being. This is possible because both scales used a variation of a 7-point Likert type scale; travel satisfaction ranging from -3 to 3, well-being ranging from 1 to 7. Travel satisfaction was measured immediately at the completion of the journey (for each trip), well-being was measured weekly, with some respondents providing well-being information twice weekly. Since the study had to be adjusted towards the latter part of the survey exercise to attract participants, the weekly interval for well-being data was reduced to a 3-day period. The y-axis denotes the time-period the data was collected. For some respondents, this may be a weekly timeframe (those that participated for a couple of weeks) and for some it was monthly (for those that were with the study for a while). Overall, the time represented the entire duration of the study.

Furthermore, due to the time interval for the collection of the two measures being compared, it is expected that the well-being of the respondent would be stable over the timeframe (since data was only collected on a [bi]weekly basis). In other words, it is assumed that due to the longer interval between readings, the well-being of the individual does not change drastically and would show some inertia compared to travel satisfaction which is more volatile and should

present more changes since data was collected more often. In sum, this comparison serves as an indicative representation of how respondents' travel satisfaction and well-being change over time for their travel mode choice.

4.5.1 Walk

Figure 4.1: Travel Satisfaction and Well-being Over Time (Walk)

Source: Author's Survey

Figure 4.1 above shows a comparison of readings for travel satisfaction and well-being over the study period for respondents whose main travel mode to work was by walking. It can be observed that the well-being for walk commuters fluctuates between levels 3 and 4.5 – the midpoints of the scale throughout the survey period. Well-being ratings start off slightly below average in the first month, progressing steadily in the second month. A dip was noticed at the beginning of the year which is to be expected as it is mid-winter and the conditions for active travellers would not have been the best during this period. The well-being eventually picks up rising a little above average for the remainder of the survey period.

Similarly, the travel satisfaction ratings of walk commuters almost mirror their well-being. Generally, travel satisfaction for this group fluctuated around the average mark, neither dipping below nor rising above. Walking commuters experienced better travel satisfaction levels either side of the new year but show a decline towards the end of the survey. It is therefore within reason to infer that walking commuters in this study were not particularly enthused about their travel mode and their well-being levels could be described as average at best.

4.5.2 Train

Figure 4.2: Travel Satisfaction and Well-being Over Time (Train)

Source: Author's Survey

The situation is quite different when the travel satisfaction and well-being ratings for train commuters within the study are considered. It can be observed that the well-being for train commuters is fairly stable over the survey time period. All the well-being ratings are significantly above the average mark with the highest ratings coming within the first two months of the year.

While the travel satisfaction ratings for train commuters show a similar trend to their well-being, the satisfaction ratings do not really impress. Travel satisfaction ratings start off just above average, rising to its highest rating in the new year, and steadily declines afterwards. As with well-being ratings, train commuters travel satisfaction ratings are highest in the first two months of the year. Furthermore, train commuters travel satisfaction ratings seem relatively bad in comparison to the other modes. This might be because they travelled the furthest distances on average for work, so they may not seem very satisfied with their travel mode. However, the well-being ratings for train commuters on average seem quite good suggesting that even though they may not be satisfied with their travel experience, this dissatisfaction does not make a significant cumulative impact on their overall well-being – having the shortest commute time on average within the study sample might be a reason for this.

4.5.3 Cycle

Figure 4.3: Travel Satisfaction and Well-being Over Time (Cycle)

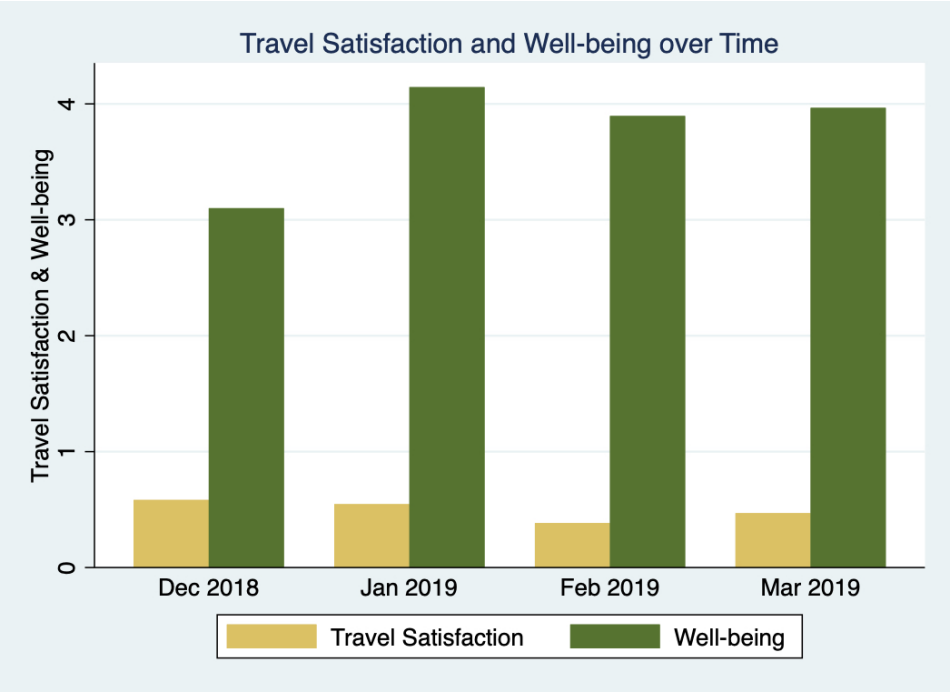
Source: Author's Survey

Figure 4.3 presents the travel satisfaction and well-being information for cycle commuters over the survey period. The well-being of respondents was fairly constant over the study period. With the exception of the two months either side of the new year, a gentle rise in well-being levels can be observed. Furthermore, the December and February months showed the highest levels of recorded well-being ratings. Just like their walk commuter counterparts, cycle commuters would have experienced a slight dip in well-being ratings due to the prevalent weather conditions in mid-winter.

Similarly, the reported travel satisfaction levels appear to also be fairly constant over the survey period. The lowest ratings were recorded at the start and end of the survey period, and the dip in travel satisfaction experienced during mid-winter was ever so slightly noticeable. Even though the travel satisfaction ratings were generally around the average mark, cycle commuters on average had the better travel satisfaction rating as compared to other travel modes over the survey period. It can thus be inferred that the while not particularly enthused about their travel satisfaction, cycle commuters were contented and their well-being levels were generally above average and good over the study period.

4.5.4 Bus

Figure 4.4: Travel Satisfaction and Well-being Over Time (Bus)



Source: Author's Survey

Figure 4.4 presents the well-being and travel satisfaction readings for the respondents whose main travel mode was by bus. It can be observed that the well-being of bus commuters fluctuated between levels 3 and 4 (the midpoint) of the scale throughout the survey period. Well-being ratings start off below the average in the first month, progressing steadily to just above average in the second month, before steadying for the remainder of the survey period.

Travel satisfaction ratings for bus commuters on the other hand shows a slight decline over the first three months with a gentle rise in the final month of the survey. However, the travel satisfaction ratings appeared to fluctuate around the average mark throughout the survey period. Also, bus commuters experienced better travel satisfaction levels within the first two months of the survey but show a decline towards the end of the survey. It is therefore within reason to infer that bus commuters in this study were not enthused about their travel mode and their well-being levels could be described as average at best. Given that bus commuters travelled for the longest time on average when compared with other travel modes to work, this might help explain the reason for the average travel satisfaction and well-being ratings.

4.5.5 Car

Figure 4.5: Travel Satisfaction and Well-being Over Time (Car)

Source: Author's Survey

The travel satisfaction and well-being ratings for respondents whose main commute mode was the car is presented in figure 4.5. The well-being ratings for car commuters was highest at the beginning of the survey period, before experiencing a sharp decline at the beginning of the year. Perhaps the big decline in well-being ratings experienced by car commuters in mid-winter is similar to active commuters weather-related experience.

The travel satisfaction ratings on the other hand makes for an interesting interpretation. The first two months of the survey sees travel satisfaction ratings fall just below the average for car commuters – in fact, travel satisfaction was negatively impacted during this period. Travel satisfaction ratings would eventually climb slightly above average for the remainder of the survey period. It is evident that car commuters on average experienced the worst travel satisfaction when compared to other travel modes within the study. While well-being levels appear to be quite good initially, it can only be summarised as average at best for the duration of the study. Interestingly, the months with travel satisfaction below the average were also the months with the highest recorded well-being ratings. Travel satisfaction eventually evens out around the average mark, and well-being ratings start climbing back up.

4.6 Mapping Travel Satisfaction and Well-being

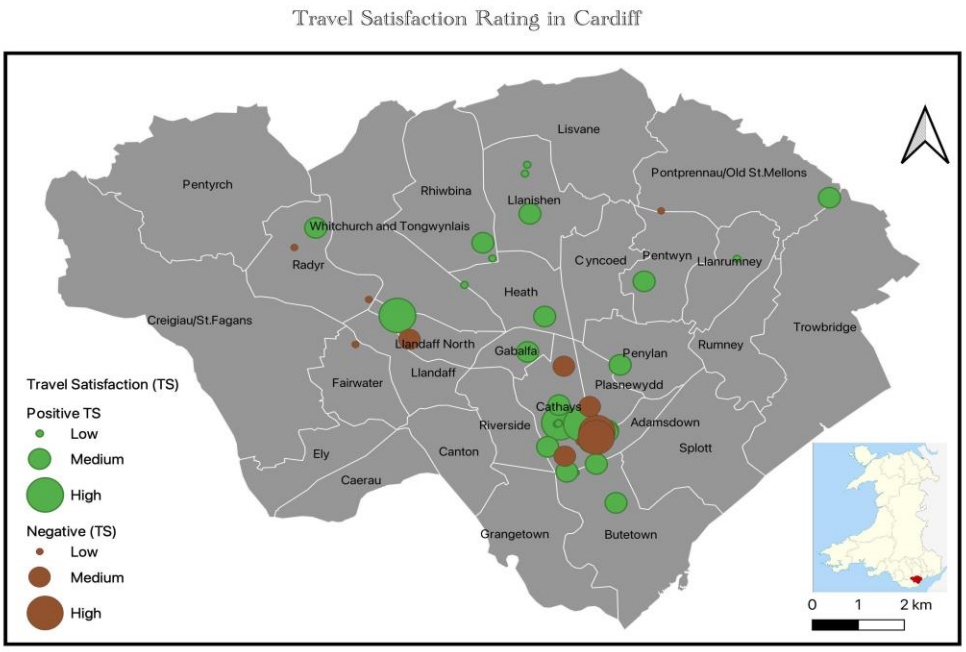
This section provides a visualisation of the variation of travel satisfaction and well-being over the geographical space of the case study area. Travel satisfaction is delineated into two, having a positive travel satisfaction rating and having a negative travel satisfaction rating. Similarly, well-being is viewed as having a high (positive) well-being rating or having a low (negative) well-being rating. Furthermore, these categories are subdivided into three levels: low, medium and high. Just like the travel satisfaction and well-being information over time, composite scores for travel satisfaction and well-being were derived for each participant and their location was plotted on a Cardiff area map using the coordinates from their travel activity tracking.

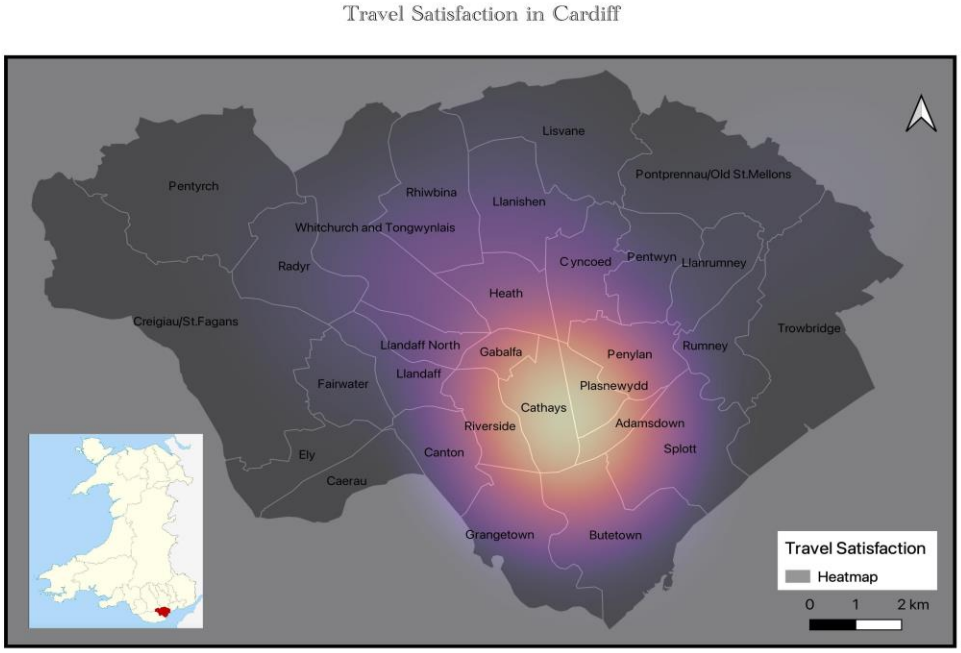
Looking at the maps there appears to be a spread of ratings around the Cardiff region with the exemption of the areas around the extremities. There is a cluster of information around Cathays, Adamsdown and Plasnewydd. This is expected since the city centre is located within this area and many respondents live and/or work not too far away from here. Generally, the map shows the presence of more positive and high ratings for travel satisfaction and well-being respectively as against negative and low ratings. These peculiarities are explored further in the subsequent maps.

4.6.1 Travel Satisfaction

Figure 4.6 shows the distribution of travel satisfaction rating in Cardiff. Positive travel satisfaction ratings greatly outnumber negative travel satisfaction ratings in the city. Around the city centre area, more negative travel satisfaction ratings can be observed in comparison to the rest of the area. Furthermore, there appears to be a large amount of high negative travel satisfaction rating around the central wards in Cathays, Adamsdown, Plasnewydd, and Llandaff North compared to other areas with negative travel satisfaction. Apart from Radyr and Fairwater in the north-west, positive travel satisfaction ratings outnumbers negative ratings in the city. The heatmap shows the intensity of the data cluster around the central wards in the city. Positive travel satisfaction ratings appear to have a more spread-out look especially for low and medium levels of positive travel satisfaction. High levels of positive travel satisfaction are concentrated within the city centre with Llandaff North the only exception.

Figure 4.6: Distribution of Travel Satisfaction Rating in Cardiff



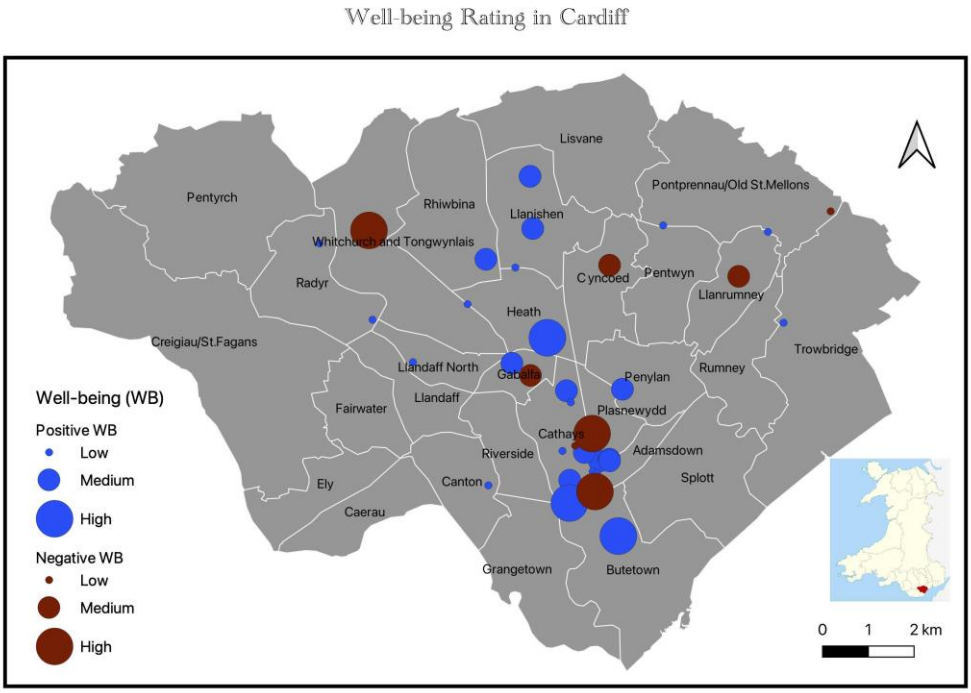


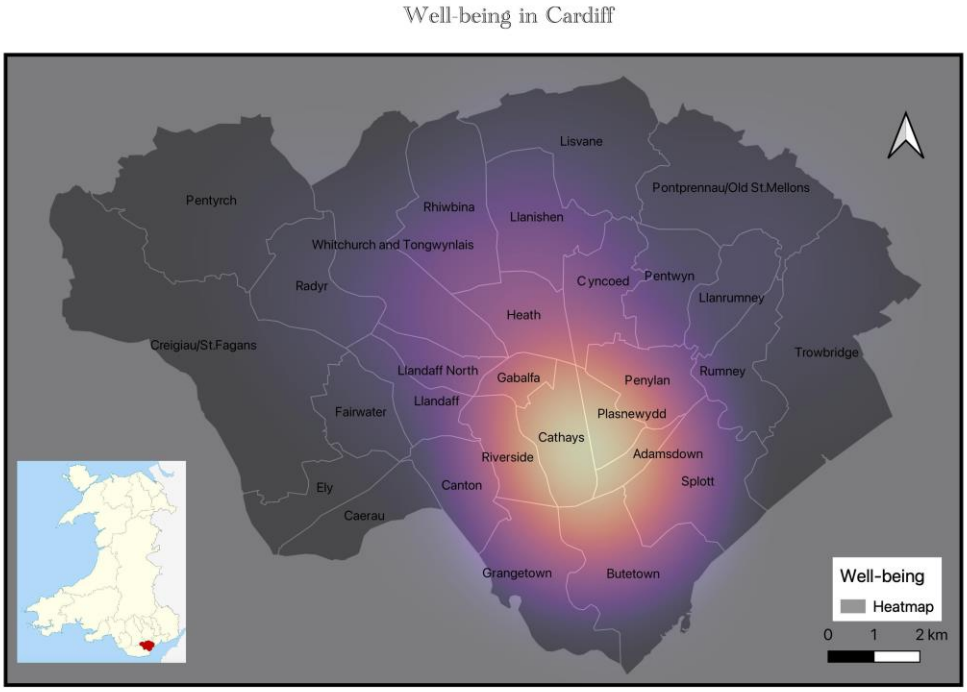
Source: Author's Survey

4.6.2 Well-being

Figure 4.7 shows the distribution of well-being rating in Cardiff. As was the case for travel satisfaction, positive well-being ratings greatly outnumber negative well-being ratings in the city. There are as many negative well-being ratings around the city centre as they are in other areas in the city. In contrast to travel satisfaction ratings, almost all the negative well-being ratings in the city are located around the central and north-eastern wards. As seen on the heatmap, almost all the ratings for positive well-being cluster around the central and southern wards in the city. Apart from Whitchurch and Tongwynlais, and Cyncoed, positive well-being ratings outnumbers negative ratings in the city and appear to have a more spread-out look. In fact, low levels of positive well-being are far more spread out than any other level of well-being ratings in Cardiff. The concentration of medium and high levels of well-being is situated along the central axis of the city.

Figure 4.7: Distribution of Well-being Ratings in Cardiff





Source: Author's Survey

4.7 Dimensions of Travel Satisfaction

4.7.1 Travel Satisfaction and Well-being

To start with, the study tries to establish if there is any relationship between the travel satisfaction experienced by respondents and their well-being. If a relationship exists, what sort of relationship is this and if no relationship exists, what would this mean? As explained earlier, travel satisfaction information was collected from respondents on a journey-by-journey basis, while well-being information was collected weekly (or bi-weekly). Consequently, the travel satisfaction and well-being dataset were quite unbalanced. To correct this, assumptions had to be made for the missing values in the well-being dataset to properly analyse the data. Since it is expected that the well-being of the respondent would not be subjected to frequent changes (being a global measure), and should remain stable over time, the Last Observation Carried Forward (LOCF) single imputation technique was employed to fill missing values. The LOCF is a widely used imputation method for longitudinal survey analysis which replaces every missing value with the last observed value for the same variable (Nakai and Ke 2011). Since this method assumes that the value of the outcome remains unchanged after missing, it offered a good solution to handling missing well-being values in the study. Using a Spearman's rank correlation (Spearman's rho), the relationship between travel satisfaction and well-being can then be assessed since they are ordinal scale data (Bryman 2016; McCarroll 2016).

Table 4.12: Summary of Relationship between Travel Satisfaction and Well-being

Variables	Travel Satisfaction	Well-being
Travel Satisfaction	1.000	
Well-being	0.1877* (0.0000)	1.000

Number of obs.(n) = 793
Spearman's rho = 0.1877
Prob > t = 0.0000

** shows significance at the .05 level*
Source: Author's Survey

From the output in Table 4.12 above, it is evident that a statistically significant positive relationship exists between the travel satisfaction experienced by respondents and their level of well-being as indicated by the p-value of 0.0000. This means that this relationship can be observed not just only in the study sample, but in the general population. However, the correlation strength is not particularly strong as indicated by the correlation co-efficient value of 0.1877. Furthermore, this positive significant relationship is monotonic in nature indicating that as the respondents travel satisfaction increases, so does their well-being and vice-versa,

however, these variables do not increase at the same rate. In sum, within the study sample and in the general population, the more satisfied one is with their travel, the higher their well-being ratings is expected to be.

4.7.2 Exploring Travel Satisfaction Across Commute Modes

Since a relationship between the respondents' travel satisfaction and well-being has been established, the research explores if a relationship exists between the respondents travel satisfaction and their commute mode of choice. Once this is established, the study further explores how this travel satisfaction changes across the various modes of travel. Thus, travel satisfaction (ordinal scale data) is denoted as the dependent variable while commute mode (categorical scale data – unordered categories) is the independent variable. The choice of the appropriate statistical analysis to use is heavily influenced by the measurement of the dependent variable (travel satisfaction, in this case) (Long and Freese 2006). When the dependent variable is a continuous scale data, ordinary least squares (OLS) regression is often used. However, when the dependent variable is an ordinal scale data, it is appropriate that ordered logistic regression technique is employed (Williams and Quiroz 2020). It is quite common to see ordinal scale data being treated as though they were continuous scale data by some researchers and OLS regression is used for model estimates. However, Menard (2002) suggested this is not good practice and could result in a misleading estimate of the independent variable effects as well as generating incorrect statistical significance. Therefore, ordered logistic regression models is the preference in these situations. In exploring the relationship between travel satisfaction (dependent variable – ordinal scale data) and commute mode (independent variable – categorical scale data), the best statistical technique to use would be an ordered logistic regression (Williams and Quiroz 2020).

Table 4.13: Summary of Travel Satisfaction across Commute Modes

Travel Satisfaction		Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Commute Mode	*Car (base outcome)*		.	.	.	.	.	.	
	Bus	.267	.238	1.306	1.12	.261	-.199	.733	
	Cycle	1.224	.21	3.401	5.82	0.00	.812	1.636	***
	Train	.323	.229	1.382	1.41	.159	-.126	.773	
	Walk	.975	.21	2.652	4.65	0.00	.564	1.386	***
cut1		*-1.646*	*.187*		*b*	*b*	*-2.013*	*-1.279*	
cut2		*.293*	*.174*		*.b*	*.b*	*-.048*	*.633*	

Mean dependent var	0.519	SD dependent var	0.656
Pseudo r-squared	0.029	Number of obs. (n)	1056
Chi-square	54.251	Prob > chi2	0.000
Akaike crit. (AIC)	1816.643	Bayesian crit. (BIC)	1846.417

*** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).

Source: Author's Survey

In the output above, it can be deduced that a significant relationship exists when the respondents experienced travel satisfaction is compared with their commute modes. The likelihood ratio chi-square of 54.25 with a p-value of 0.0000 suggests that the model is statistically significant. Delving deeper, travel satisfaction is split across 5 commute modes in the output. These modes are travelling by bus, car, cycle, train and walk. In comparing travel satisfaction across these modes, car journey is denoted as the baseline category. As such, all other commute modes are compared to car journeys when presenting the result. All coefficient values for the commute categories are positive, indicating an increase in the probability of falling at a higher level for travel satisfaction. In addition, the odds ratio is interpreted for the results rather than the coefficients as they provide a better understanding of the data. These values were 1.306 for bus, 3.401 for cycle, 1.382 for train, and 2.652 for walk.

What this translates to is that; for respondents whose main commute mode is by bus, the odds of them being in a higher category for travel satisfaction is 1.306 times higher than respondents in the reference category. In other words, bus commuters are 1.306 times more likely to be satisfied with their journeys when compared with car commuters – however, this is not significant and only true of the study group. Respondents whose main commute mode is by cycle, the odds of them being at a higher category for travel satisfaction is 3.401 times higher than the reference category. This means that cycle commuters are 3.401 times more likely to be satisfied with their journeys than car commuters. And since this value is significant, the assumption holds true for both the study group and the general population. For respondents whose main commute mode is by train, the evidence suggests that the odds of being at a higher category for travel satisfaction is 1.382 times higher for them in comparison to those in the reference category. Therefore, train commuters within the study are 1.382 times more likely to be satisfied with their journeys than car commuters – however this is not significant, and the assumption cannot be inferred on the general population. Lastly, for respondents whose main commute mode is by walk, the odds of them being at a higher category for travel satisfaction is 2.652 times higher than respondents in the reference category. This suggests that commuters who chose to walk were 2.652 times more likely to be satisfied with their journeys than car commuters. Furthermore, since this result is significant, the assumption holds true for both the study group and the general population.

4.7.3 Exploring the impact of Commute Distance on Travel Satisfaction

The relationship that exists between the distance travelled for work and travel satisfaction is explored in this section. Travel satisfaction is treated as the response variable (dependent) and commute distance as the predictor variable (independent). Furthermore, since travel satisfaction is an ordinal scale variable, ordered logistic regression is used in modelling the results as previously explained.

Table 4.14: Travel Satisfaction and Commute Distance

Travel Satisfaction	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Distance (km)	-.017	.013	.983	-1.39	.166	-.042	-.007	
cut1	*-2.409*	*.128*		*.b*	*.b*	*-2.659*	*-2.158*	
cut2	*-.535*	*.092*		*.b*	*.b*	*-.715*	*-.355*	

Mean dependent var	0.519	SD dependent var	0.656
Pseudo r-squared	0.001	Number of obs. (n)	1056
Chi-square	1.916	Prob > chi2	0.166
Akaike crit. (AIC)	1862.979	Bayesian crit. (BIC)	1877.866

**** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).

Source: Author's Survey

The model in Table 4.14 shows that the commute distance of the respondents does not have a significant relationship on their travel satisfaction. This is indicated by the Prob > chi2 of 0.166 which is not significant at 0.05. Furthermore, the results show a negative relationship exists between the travel satisfaction of respondents and the distance travelled. The regression coefficient indicates that for every 1 km increase in distance travelled, there is a predicted decrease of 0.017 in the log odds of being at a higher travel satisfaction rating. Given that the odds ratio is < 1 (0.983), there is a decreasing probability of the respondent being at a higher rating for travel satisfaction as distance travelled increase. Therefore, the longer the distance travelled for work, the lower the reported travel satisfaction of the respondents is predicted to be within the study. However, because this value is not significant, there is not enough evidence to support that this assumption is true for the general population.

4.7.4 Exploring the impact of Commute Time on Travel Satisfaction

The relationship that exists between travel satisfaction and time taken to travel to work is explored next. Travel satisfaction is treated as the response variable (dependent) and commute time as the predictor variable (independent). Furthermore, since travel satisfaction

is an ordinal scale variable, ordered logistic regression is used in modelling the results as previously explained.

Table 4.15: Travel Satisfaction and Commute Time

Travel Satisfaction	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Duration (mins)	-.003	.005	.997	-0.53	.595	-.013	.007	
cut1	*-2.377*	*.16*		*.b*	*.b*	*-2.691*	*-2.063*	
cut2	*-.505*	*.134*		*.b*	*.b*	*-.768*	*-.243*	
Mean dependent var			0.519	SD dependent var			0.656	
Pseudo r-squared			0.000	Number of obs. (n)			1056	
Chi-square			0.282	Prob > chi2			0.595	
Akaike crit. (AIC)			1864.613	Bayesian crit. (BIC)			1879.499	

**** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).

Source: Author's Survey

The model in Table 4.15 shows that there is no significant relationship between the commute time of the respondents and their travel satisfaction. This is indicated by the Prob > chi2 of 0.595 which is not significant at 0.05. However, the result show that a negative relationship exists between travel satisfaction and commute time for respondents within the study. The regression coefficient indicates that for every 1 min increase in commute time, there is a predicted decrease of 0.003 in the log odds of being at a higher travel satisfaction rating. Given that the odds ratio is < 1 (0.997), there is a decreasing probability of the respondent being at a higher rating for travel satisfaction as time travelled increases. Therefore, the longer the time travelled for work, the lower the reported travel satisfaction of the respondents is predicted to be within the study (although again, this is not a significant predictor and is not true for the general population).

4.7.5 Exploring Travel Satisfaction Using Socio-Demographic Factors

In exploring the relationship between travel satisfaction and the socio-demographic conditions of the respondents, the best metric needed to be included in the analysis. To this end, the previous three models (travel satisfaction across commute modes, travel satisfaction and commute distance, and travel satisfaction and commute time) also served the purpose of selecting the model that provided the best metric to be included with the selected socio-demographic factors to explain the relationship between travel satisfaction and socio-demographic factors. The overall aim of this is getting a good fit for the subsequent model. From the aforementioned models, the model with travel satisfaction across commute modes

provided the best metric out of the three, hence its adoption here. In addition, the socio-demographic variables included were gender, age, income, number of people in household, number of cars in the household, and weekly work hours – all of which were selected from the review of several literatures discussed in the literature review chapter.

With evidence showing that there is a significant relationship when travel satisfaction is compared across the travel modes, the study explores whether the socio-demographic conditions of the respondents affected the travel satisfaction they experienced. A standard logistic regression model would not be the most appropriate way of running the model. This is because due to the nested nature of the data (one respondent providing several activity data, hence activities were nested in respondents' repeated measures), the assumption of independence – all observations independent of one another – is voided (Bressoux 2010). Therefore the relationship across selected socio-demographic variables, commute mode and travel satisfaction would best be observed by using a multilevel logistic regression model (Sommet and Morselli 2017).

In multilevel logistic modelling, cluster numbers (respondents – in this study) are more important than observation numbers (activities – in this study) (Sommet and Morselli 2017). Studies have shown that 50 or more cluster units are necessary to accurately estimate standard errors in multilevel logistic models (Paccagnella 2011; Swaminathan et al. 2011). For this model, the cluster numbers were 57 (respondents) and the observation numbers were 1,056 (activities), all of which satisfy the conditions for using the multilevel logistic model. Travel satisfaction was denoted as the dependent variable, while the selected socio-demographic factors and commute mode were the independent variables. Table 4.14 presents the results of the analysis.

Table 4.16: Summary of Relationship between Travel Satisfaction and Socio-Demographic Variables

Travel Satisfaction	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Gender *(Female)*	.	.	.	.	.	.	.	
Male	.017	.4	2.102	0.04	.967	-.767	.801	
Age *(<30)*	.	.	.	.	.	.	.	
30-35	.222	.496	1.249	0.45	.655	-.751	1.195	
36-39	.705	.459	2.024	1.54	.125	-.195	1.606	
40-45	-.103	.497	.902	-0.21	.836	-1.077	.871	
46-49	.005	.564	1.005	0.01	.993	-1.1	1.109	
50 and above	-.067	.556	.936	-0.12	.905	-1.156	1.023	
Number of People in Household	.136	.168	1.146	0.81	.418	-.193	.465	

Income *(<£20,000)*	.	.	.	.	.	.	.	
£20,000-£36,399	-.396	.75	.673	-0.53	.598	-1.866	1.074	
£36,400-£51,999	.237	.713	1.268	0.33	.739	-1.159	1.634	
£52,000-£77,999	.598	.747	1.819	0.80	.423	-.866	2.063	
£78,000 and above	-.21	.889	.81	-0.24	.813	-1.953	1.533	
Weekly Work Hours *(>35hrs)*	.	.	.	.	.	.	.	
Less than 20hrs	-1.426	.899	.24	-1.59	.113	-3.187	.336	
20 – 35hrs	-.202	.361	.817	-0.56	.576	-.911	.506	
Number of Cars in Household	-.069	.254	.933	-0.27	.784	-.567	.428	
Commute Mode *(Car)*	.	.						
Bus	.246	.464	1.279	0.53	.596	-.663	1.155	
Cycle	.991	.42	2.694	2.36	.018	.169	1.814	**
Train	.12	.463	1.128	0.26	.795	-.787	1.027	
Walk	1.295	.445	3.653	2.91	.004	.422	2.168	***
cut1	*-1.558*	*1.107*		*.b*	*.b*	*-3.729*	*.612*	
cut2	*.634*	*1.102*		*.b*	*.b*	*-1.526*	*2.794*	
var(cons) userid	.47	.179		.b	.b	.223	.992	
var(cons) userid>activityid	0	0		.b	.b	.	.	

Mean dependent var	0.519	SD dependent var	0.656
Chi-square	38.407	Prob > chi2	0.005
Akaike crit. (AIC)	1730.431	Number of obs. (n)	1056

**** p<.01, ** p<.05, * p<.1*
(variable) – base outcome
Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).
Source: Author's Survey

From the model above, the socio-demographic characteristics of the respondents do affect their travel satisfaction. The evidence suggests there is significant relationship between the respondents' socio-demographic factors and their travel satisfaction. This is indicated by the Prob > chi2 value of 0.005 which is significant at 0.05.

However, none of the selected socio-demographic variables was significant at 0.05. This means that by themselves, any relationships observed between travel satisfaction and each socio-demographic variable while controlling for commute mode only applies to the study sample with no sufficient evidence to suggest occurrence in the general population. That said, the following paragraphs summarise the relationships observed.

Evidence from the study shows that a positive relationship exists between gender and travel satisfaction, albeit one which is not significant. This evidence suggests that on average, the log odds of being in a higher category for travel satisfaction is 0.017 points greater for men than women. And the odds of a respondent identified as male in a higher category for travel satisfaction is 2.102 times that of a respondent identified as female. Since this relationship is positive, we can infer that men are more likely to report higher levels of travel satisfaction when compared to women within the study sample when controlled for other demographic factors and commute mode (although again, gender is not a significant predictor).

In terms of age, the results indicate that there is no significant relationship between the age of respondents and their reported travel satisfaction when controlling for other demographic factors and commute mode within the sample. However, except for respondents in the 40-45 and 50 and above age categories, all the coefficients were positive for all age groups when compared with the reference age category of below 30. The evidence suggests that for respondents within the age group of 40-45 the odds of them being in a higher category for travel satisfaction is 0.902 times lower than respondents in the reference category when holding all other socio-demographic factors, and commute mode constant. Also, for respondents who are aged 50 and above, the odds of them being in a higher category for travel satisfaction is 0.556 times lower than respondents below 30 years when holding all other socio-demographic factors, and commute mode constant. In other words, respondents in these age categories are less satisfied with their travel compared with younger respondents (although again, age is not a significant predictor).

The number of people living in the household show a positive relationship with the travel satisfaction experienced by the respondent. The regression coefficient indicates that for every 1 unit increase in the number of people in the household, there is a predicted increase of 0.136 in the log odds of being in a higher category for travel satisfaction while controlling for the other predictors. Also, the odds ratio indicates that the odds of having a higher rating for travel satisfaction increases by a factor of 1.146 for every 1 unit increase in the number of people living in the household. This means that within the sample, respondents who live in households with more people are more likely to report a higher travel satisfaction when controlling for all other socio-demographic factors and commute mode.

Apart from respondents who earned between £20,000-£36,399 and over £78,000, the odds ratio for all income categories shows a positive relationship exists between income and travel satisfaction when compared with the reference category of respondents that earn less than £20,000. Indicative that the higher you earn, the more likely you are to report higher levels of

travel satisfaction. However, the evidence suggests that for respondents who earned between £20,000-£36,399, the odds of them being in a higher category for travel satisfaction is 0.673 times lower than respondents in the reference category when holding all other socio-demographic factors and commute mode constant. Also, for respondents who earned £78,000 and above, the odds of them being in a higher category for travel satisfaction is 0.810 times lower than respondents who earned less than £20,000 when holding all other socio-demographic factors and commute mode constant. In other words, while respondents who earned higher were more satisfied with their commutes, respondents in the aforementioned salary categories were less satisfied with their travel compared to the lowest earners (although again, income is not a significant predictor).

There is no significant relationship between the weekly work hours of the respondents and their reported travel satisfaction when controlling for other demographic factors and commute mode within the sample. The regression coefficients were negative for all groups when compared with the reference work hour category of respondents who worked over 35 hours weekly. The evidence suggests that for respondents who worked less than 20 hours weekly the odds of them being in a higher category for travel satisfaction is 0.240 times lower than respondents in the reference category when holding all other socio-demographic factors and commute mode constant. Furthermore, for respondents who worked between 20hrs and 35hrs weekly, the odds of them being in a higher category for travel satisfaction is 0.817 times lower than respondents who worked over 35hrs weekly when holding all other socio-demographic factors, and commute mode constant. In other words, respondents who worked lesser weekly hours are less satisfied with their travel compared with respondents who worked over 35hrs weekly (although again, hours worked weekly is not a significant predictor).

The number of cars in the household show a negative relationship with the travel satisfaction experienced by the respondent. The regression coefficient indicates that for every 1 unit increase in the number of cars in the household, there is a predicted decrease of 0.067 in the log odds of being in a higher category for travel satisfaction while controlling for the other socio-demographic characteristics including commute mode. Also, the odds ratio indicates that the odds of a respondent having a higher rating for travel satisfaction decrease by a factor of 0.933 for every 1 unit increase in the number of cars in the household. This means that within the sample, respondents who live in households with more cars are less likely to report a higher travel satisfaction.

Summarily, the socio-demographic characteristics of the respondents is a significant predictor of their travel satisfaction. However, the individual characteristics on their own do not provide

any statistical significance with travel satisfaction. Despite this, a myriad of information can be deduced from the model. The non-significance only shows that the study sample is too small to be used to make a generalised conclusion for the entire population.

4.8 Dimensions of Well-being

4.8.1 Exploring Well-being Across Commute Modes

The following analyses would try to understand the relationships that exists between the respondents' well-being and other related variables vis-à-vis the travel mode of choice, their commute distance, their commute time and their socio-demographic characteristics. In this section, the relationship that exists between well-being and the various commute modes are explored. Once this is established, the study further explores how this well-being changes across the various modes of travel. To explore this relationship, an ordered logistic regression is used. This analysis technique works best because the dependent variable (well-being) is an ordinal scale data, and the independent variable (commute mode) is also ordinal in nature. The reason for the use of the statistical technique has been explained in detail in the previous section.

Table 4.17: Summary of Well-being across Commute Modes

Well-being		Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Commute Mode	*Car (base outcome)*	.	.	.	.	.	.	.	
	Bus	.122	.258	1.13	0.47	.636	-.384	.629	
	Cycle	.817	.234	2.265	3.49	0.000	.359	1.276	***
	Train	1.631	.299	5.108	5.45	0.000	1.044	2.217	***
	Walk	-.139	.241	.87	-0.58	.563	-.612	.333	
cut1		*-1.01*	*.216*		*.b*	*.b*	*-1.433*	*-.586*	
cut2		*.581*	*.214*		*b*	*b*	*.162*	*1*	

Mean dependent var	0.282	SD dependent var	0.772
Pseudo r-squared	0.041	Number of obs. (n)	976
Chi-square	83.954	Prob > chi2	0.000
Akaike crit. (AIC)	1953.872	Bayesian crit. (BIC)	1983.172

**** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).

Source: Author's Survey

From the output in Table 4.17, it can be deduced that a significant relationship exists when the respondents' well-being is compared with their commute modes. The likelihood ratio chi-square of 83.95 with a p-value of 0.0000 indicates that the model is statistically significant.

Well-being is split across 5 commute modes in the output model. These modes are travelling by bus, car, cycle, train and walk. In comparing well-being across these modes, car commute is denoted as the baseline category. As such, all other commute modes are compared to car journeys when presenting the result. Apart from walk commutes, all coefficient values for the commute categories are positive, indicating an increase in the probability of falling at a higher level for well-being. And the negative coefficient for walk commutes indicates a decrease in the probability of falling at a higher level for well-being. In addition, the odds ratio is interpreted for the results rather than the coefficients as these provide a better understanding of the data. These values were 1.130 for bus, 2.265 for cycle, 5.108 for train, and 0.870 for walk.

This suggests that for respondents whose main commute mode is by bus, the odds of being in a higher category for well-being is 1.130 times higher than respondents in the reference category. In other words, bus commuters are 1.130 times more likely to elicit higher ratings for well-being when compared with car commuters – however, this is not significant and only true of the sample. Respondents whose main commute mode is by cycle, the odds of them being at a higher category for well-being is 2.265 times higher than the reference category. This means that cycle commuters are 2.265 times more likely to elicit higher well-being ratings than car commuters. And since this value is significant, the assumption holds true for both the study group and the general population. For respondents whose main commute mode is by train, the evidence suggests that the odds of being at a higher category for well-being is 5.108 times higher for them in comparison to those in the reference category. Therefore, train commuters within the study sample and in the general population are 5.108 times more likely to report higher ratings for well-being than car commuters. Lastly, for respondents whose main commute mode is by walk, the odds of them being at a higher category for well-being is 0.870 times lower than respondents in the reference category. This suggests that commuters who chose to walk were 0.870 times less likely to report higher ratings for well-being than car commuters. However, this assumption is not significant and only holds true for the sample.

4.8.2 Exploring the impact of Commute Distance on Well-being

The relationship that exists between the distance travelled for work and the rating for well-being is explored in this section. Well-being is treated as the response variable (dependent) and commute distance as the predictor variable (independent). Furthermore, since well-being is an ordinal scale variable, ordered logistic regression is used in modelling the results (Williams and Quiroz 2020).

Table 4.18: Well-being and Commute Distance

Well-being	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Distance (km)	.047	.016	1.048	3.04	.002	.017	.078	***
cut1	*-1.182*	*.109*		*.b*	*.b*	*-1.395*	*-.969*	
cut2	*.321*	*.1*		*.b*	*.b*	*.125*	*.517*	

Mean dependent var	0.282	SD dependent var	0.772
Pseudo r-squared	0.005	Number of obs. (n)	976
Chi-square	9.516	Prob > chi2	0.002
Akaike crit. (AIC)	2022.309	Bayesian crit. (BIC)	2036.959

**** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).

Source: Author's Survey

Table 4.18 shows that the commute distance travelled have a significant relationship on respondents' well-being. This is indicated by the Prob > chi2 of 0.002 which is significant at 0.05. This means that as much as this assumption is true for the study sample, there is enough evidence to support that the existence of the relationship in the general population is not a random occurrence. Furthermore, a significant positive relationship exists between the well-being of respondents and the distance travelled. The regression coefficient indicates that for every 1 km increase in distance travelled, there is a predicted increase of 0.047 in the log odds of being at a higher well-being rating. Given that the odds ratio is > 1 (1.048), there is an increasing probability of the respondent being at a higher rating for well-being as distance travelled increase. Therefore, the longer the distance travelled for work, the higher the reported rating for respondents' well-being is predicted to be within the study and in the general population. This is rather fascinating as the reverse would be expected because as the distance travelled increases, it should be expected that people would report lower well-being ratings. However, findings from this study have shown that train commuters who travelled the farthest distances for work have the highest well-being ratings. Activities undertaken during the commute (reading a book or socialising for example) might help to explain this.

4.8.3 Exploring the impact of Commute Time on Well-being

The relationship that exists between well-being and time taken to travel to work is explored next. As before, well-being is treated as the response variable (dependent) and commute time as the predictor variable (independent). Furthermore, since well-being is an ordinal scale variable, ordered logistic regression is used in modelling the results (Williams and Quiroz 2020).

Table 4.19: Well-being and Commute Time

Well-being	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Duration (mins)	-.019	.005	.982	-3.63	0.0003	-.029	-.009	***
cut1	*-1.855*	*.149*		*.b*	*.b*	*-2.147*	*-1.563*	
cut2	*-.346*	*.136*		*.b*	*.b*	*-.612*	*-.081*	

Mean dependent var	0.282	SD dependent var	0.772
Pseudo r-squared	0.007	Number of obs. (n)	976
Chi-square	13.373	Prob > chi2	0.0003
Akaike crit. (AIC)	2018.452	Bayesian crit. (BIC)	2033.102

**** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).

Source: Author's Survey

Table 4.19 shows that the commute time travelled have a significant relationship on respondents' well-being. This is indicated by the Prob > chi2 of 0.0003 which is significant at 0.05. This means that as much as this assumption is true for the study sample, there is enough evidence to support that the existence of the relationship in the general population is not by chance. Furthermore, a significant negative relationship exists between the well-being of respondents and the time travelled. The regression coefficient indicates that for every 1 min increase in commute time, there is a predicted decrease of 0.019 in the log odds of being at a higher well-being rating. Given that the odds ratio is < 1 (0.982), there is a decreasing probability of the respondent being at a higher rating for well-being as commute time increase. Therefore, the longer time it takes to travel for work, the lower the reported well-being rating of the respondents is predicted to be within the study and in the general population.

4.8.4 Exploring Well-being Using Socio-Demographic Factors

The process of modelling the outcome between well-being and socio-demographic factors is similar to how the outcome for travel satisfaction and socio-demographic factors was modelled earlier. The three well-being models discussed above (well-being across commute modes, well-being and commute distance, and well-being and commute time) also served the purpose of estimating the model with the best metric to provide a good fit when explaining the relationship between well-being and socio-demographic factors. As such, the well-being model depicting the relationship across commutes modes provided the best metric of the three, hence its subsequent adoption. Also, the socio-demographic variables included were gender, age, income, number of people in household, number of cars in the household, and

weekly work hours – all of which were selected from the review of several literatures discussed in the literature review chapter.

A multilevel ordered logistic regression was used previously when the relationship between travel satisfaction and socio-demographic characteristics were explored. However, since this particular combination of variables do not fulfil the minimum cluster unit (level 2) requirement of 50 or more units, an ordered logistic regression would be employed (Swaminathan et al. 2011). For this model, the cluster numbers were 41 (respondents) and the observation numbers were 976 (activities). Well-being was denoted as the dependent variable, while the selected socio-demographic factors and commute mode were the independent variables. Table 4.20 presents the results of the analysis.

Table 4.20: Summary of Relationship between Well-being and Socio-Demographic Variables

Well-being	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Gender *(Female)*	.	.	.	.	.	.	.	
Male	-.586	.442	.556	-1.33	.185	-1.453	.281	
Age *(<30)*	.	.	.	.	.	.	.	
30-35	-2.287	.538	.102	-4.25	0.000	-3.342	-1.232	***
36-39	-2.26	.516	.104	-4.38	0.000	-3.272	-1.249	***
40-45	-.508	.499	.602	-1.02	0.308	-1.486	.469	
46-49	-2.003	.521	.135	-3.84	0.000	-3.024	-.981	***
50 and above	-7.499	.584	.001	-12.85	0.000	-8.643	-6.355	***
Number of People in Household	-.993	.215	.37	-4.62	0.000	-1.415	-.572	***
Income *(<£20,000)*	.	.	.	.	.	.	.	
£20,000-£36,399	2.849	.557	17.263	5.11	0.000	1.756	3.941	***
£36,400-£51,999	2.933	.636	18.785	4.61	0.000	1.686	4.18	***
£52,000-£77,999	9.642	1.184	15403.332	8.14	0.000	7.322	11.963	***
£78,000 and above	3.335	.993	28.079	3.36	0.001	1.388	5.282	***
Weekly Work Hours *(>35hrs)*	.	.	.	.	.	.	.	
Less than 20hrs	3.112	1.129	22.467	2.76	.006	.9	5.324	***
20 – 35hrs	-3.139	.559	.043	-5.62	0.000	-4.234	-2.043	***
Number of Cars in Household	1.066	.43	2.902	2.48	.013	.222	1.909	**
Commute Mode *(Car)*	.	.	.	.	.	.	.	
Bus	-.928	.685	.395	-1.35	.176	-2.271	.416	
Cycle	-.855	.482	.425	-1.77	.076	-1.799	.09	*
Train	.583	.661	1.792	0.88	.377	-.712	1.878	
Walk	.462	.507	1.588	0.91	.362	-.531	1.456	
cut1	*-6.788*	*1.131*		*.b*	*.b*	*-9.004*	*-4.571*	
cut2	*-3.284*	*1.127*		*.b*	*.b*	*-5.494*	*-1.074*	

Mean dependent var	0.282	SD dependent var	0.772
Pseudo r-squared	0.442	Number of obs. (n)	976
Chi-square	894.919	Prob > chi2	0.000
Akaike crit. (AIC)	1172.906	Bayesian crit. (BIC)	1275.459

*** p<.01, ** p<.05, * p<.1
(variable) – base outcome
Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).
Source: Author's Survey

From the model above, the socio-demographic characteristics of the respondents do affect their reported well-being. There is a significant relationship between the respondents' socio-demographic factors and their well-being as indicated by the Prob > chi2 of 0.000 which is significant at 0.05. And due to the statistical significance of the relationship, it can be assumed that this is not only true for the study sample but also the general population. Apart from gender, the evidence also suggests all the selected socio-demographic characteristics show a statistical significance when controlled for commute mode. Therefore, we can infer that these findings occur not only within the study sample but also in the general population.

From the output model, a negative relationship exists between gender and well-being, albeit one which is not significant. This evidence suggests that on average, the log odds of being in a higher category for well-being rating is 0.586 points lower for men than women. Also, the odds of a respondent identified as male in a higher category for well-being rating is 0.556 times that of a respondent identified as female. Since this relationship is negative, we can assume that men are less likely to report higher levels of well-being when compared to women within the study sample when controlled for other demographic factors and commute mode (although again, gender is not a significant predictor).

Except for respondents in the 40-45 age category, all other age categories show a significant relationship when compared to the reference age category of respondents younger than 30 years. Also, all age categories show a negative relationship in comparison with the reference age category. For respondents within the age category of 40-45, the odds of them being at a higher level for well-being is 0.602 times lower than for those in the reference category when holding all other socio-demographic factors and commute mode constant (although this category was not statistically significant). In a more general sense, the results indicate that the odds of being in a higher category for well-being reduces for older age categories when compared with the reference age category of respondents below 30 years old after controlling for socio-demographics and commute mode. Furthermore, evidence suggests that as you move from one age category to the next higher category, negative well-being ratings become

worse, peaking at the 40-45 age category (mid-life) before tapering down as you move to the oldest age category.

The number of people living in the household show a significant negative relationship with the well-being ratings of the respondent. The regression coefficient indicates that for every 1 unit increase in the number of people in the household, there is a predicted decrease of 0.993 in the log odds of being in a higher category for well-being ratings while controlling for the other predictors. Also, the odds ratio indicates that the odds of having a higher rating for well-being decreases by a factor of 0.370 for every 1 unit increase in the number of people living in the household. This means that within the sample and in the general population, respondents who live in households with more people are likely to report a lower level of well-being.

All income categories show a significant positive relationship when compared with the reference category of respondents earning less than £20,000 annually. This finding suggests that on average respondents who earned more than £20,000 annually are more likely to report higher levels of well-being when controlled for other demographic factors and commute mode – and this is a significant predictor. Perhaps the most interesting finding here suggest that for respondents who earned between £52,000 and £77,999, the odds of them being at a higher level for well-being is 15403.332 times higher than for those in the reference category when holding all other socio-demographic factors and commute mode constant. In comparison to the other higher income categories, this might be indicative of a 'sweet spot' when it comes to annual earnings.

In terms of weekly work hours, all the categories show a significant relationship when compared with the reference category of respondents who worked more than 35hrs weekly. For respondents who worked less than 20hrs weekly, the odds of them being at a higher level for well-being is 22.467 times higher than for those in the reference category when holding all other socio-demographic factors and commute mode constant. This means that, within the study sample and in the general population, respondents who worked less than 20hrs weekly (part-time workers most likely) are more likely to report higher well-being ratings than respondents who worked more than 35hrs weekly (these would most likely be regular overtime workers). Surprisingly, for respondents who worked between 20hrs and 35hrs weekly, the odds of them being at a higher level for well-being is 0.043 times lower than for those in the reference category when holding all other socio-demographic factors and commute mode constant. This suggests that within the study sample and in the general population, respondents who worked between 20hrs and 35hrs weekly (indicative of full-time workers) are more likely to report lower well-being ratings than respondents who worked more than 35hrs

weekly (regular overtime workers). Since the evidence suggests that people in higher income categories report higher levels of well-being, perhaps the extra income from working more hours might explain why regular overtime workers reported higher levels of well-being than full-time workers.

The number of cars in the household show a significant positive relationship with the well-being ratings of the respondent while controlling for other socio-demographic factors and commute mode. The regression coefficient shows that for every 1 unit increase in the number of cars in the household, there is a predicted increase of 1.066 in the log odds of being in a higher level of well-being. Also, the odds ratio shows that the odds of a respondent being at a higher level of well-being increases by a factor of 2.902 for every 1 unit increase in the number of cars in the household. This means that within the sample and in the population, respondents who live in households with more cars are more likely to report a higher level of well-being.

Summarily, the socio-demographic characteristics of the respondents is a significant predictor of their well-being. Furthermore, the evidence suggests that asides from gender, all the selected individual socio-demographic factors show a significant relationship with well-being after controlling for other socio-demographic factors and commute mode.

4.9 Dimensions of Commuting Behaviour

4.9.1 Exploring the Relationship across Travel Satisfaction, Well-being, and Commuting Behaviour

Next, the study tries to establish if there is any relationship across commuting behaviour, the travel satisfaction experienced by respondents and their reported well-being. Commuting behaviour is made up of a compilation of statements on commuting attitudes and behaviours from the review of literature measured on a 7-point Likert scale ranging from “strongly disagree” to “strongly agree”. The Cronbach alpha score of 63% for internal consistency obtained for this scale shows that this scale is acceptable for measuring commuting behaviour for this study. Using a Spearman’s rank correlation coefficient (Spearman’s rho), the relationship across commuting behaviour, travel satisfaction and well-being can be assessed since they are ordinal in nature (Bryman 2016; McCarroll 2016).

Table 4.21: Summary of Relationship across Commuting Behaviour, Travel Satisfaction and Well-being

Variables	Commuting Behaviour	Travel Satisfaction	Well-being
Commuting Behaviour	1.000		
Travel Satisfaction	-0.1179*	1.000	
	(0.000)		
Well-being	0.2721*	0.1877*	1.000
	(0.003)	(0.000)	
Number of obs. (n) = 793			
Prob > t = 0.0000			

** shows significance at the .05 level*

Source: Author's Survey

To start with, a significant negative relationship can be seen between the respondents' commuting behaviour and attitudes and their travel satisfaction. This indicates that within the study sample, there is evidence that the respondents' commuting behaviour and attitudes negatively affect their travel satisfaction. Moreover, evidence suggests that this relationship is not a random occurrence and can be seen in the wider population. However, the value of the negative correlation coefficient indicates this is a weak relationship. Moreover, a moderate strength significant positive relationship can be observed between the respondents' commuting behaviour and attitudes and their well-being. This indicates that within the study sample and in the general population, the respondents commuting behaviour and attitudes positively affect their well-being.

4.9.2 Exploring the Relationship Between Commuting Behaviour and Neighbourhood Quality

This test explores the relationship that exists between the respondents' commuting behaviour and attitudes and their neighbourhood quality. Neighbourhood quality is made up of a compilation of statements accessing the respondents' accessibility to basic amenities, healthcare, a safe place to live, transportation facilities, infrastructure and services within their residential area. These were from the review of literature and measured on a 7-point Likert scale ranging from "extremely dissatisfied" to "extremely satisfied". The Cronbach alpha score of 81% for internal consistency obtained for this scale shows that this scale is acceptable for measuring neighbourhood quality for this study. Using a Spearman's rank correlation coefficient (Spearman's rho), the relationship between commuting behaviour and neighbourhood quality can be assessed since they are ordinal scale data (Bryman 2016; McCarroll 2016).

Table 4.22: Summary of Relationship between Commuting Behaviour and Neighbourhood Quality

Variables	Commuting Behaviour	Neighbourhood Quality
Commuting Behaviour	1.000	
Neighbourhood Quality	0.3205* (0.000)	1.000
Number of obs. (n) = 1287		
Spearman's rho = 0.3205		
Prob > t = 0.0000		

** shows significance at the .05 level*

Source: Author's Survey

The output in Table 4.22 suggests that there is a significant positive relationship between the commuting behaviour and attitudes of respondents and their neighbourhood quality.

The co-efficient value (0.3205) shows a moderate strength relationship existing between commuting behaviour and neighbourhood quality. Furthermore, the evidence suggests this occurrence exists not only within the study sample but in the wider population. This indicates that respondents who resided in higher quality neighbourhoods, are more likely to have their commuting behaviour and attitudes positively influenced.

4.9.3 Exploring the Relationship across Travel Satisfaction, Well-being, and Neighbourhood Quality

Lastly, the study tries to establish if there is any relationship across neighbourhood quality, the travel satisfaction experienced by respondents and their reported well-being. Using a Spearman's rank correlation (Spearman's rho), the relationship across neighbourhood quality, travel satisfaction and well-being can be assessed since they are ordinal in nature (Bryman 2016; McCarroll 2016).

Table 4.23: Summary of Relationship across Neighbourhood Quality. Travel Satisfaction and Well-being

Variables	**Neighbourhood Quality**	**Travel Satisfaction**	**Well-being**
Neighbourhood Quality	1.000		
Travel Satisfaction	0.0672 (0.2348)	1.000	
Well-being	0.4200* (0.000)	0.1877* (0.000)	1.000
Number of obs. (n) = 793			
Prob > t = 0.0000			

** shows significance at the .05 level*

Source: Author's Survey

To start with, a positive relationship can be seen between the respondents' neighbourhood quality and their travel satisfaction. This indicates that within the study sample, there is evidence that the respondents' neighbourhood quality positively influences their travel satisfaction. However, evidence suggests that this relationship is not significant and cannot be observed in the wider population. Also, the value of the positive correlation coefficient indicates this is a weak relationship. Moreover, a mid-strength significant positive relationship can be observed between the respondents' neighbourhood quality and their well-being. This indicates that within the study sample and in the general population, the respondents' neighbourhood quality positively affects their well-being.

4.10 Dimensions of Mood

4.10.1 Exploring Mood Responses at Different Time Intervals

This section explores the changes in moods experienced by the respondents at specific intervals. These moods were a measure of how happy (valence) or how active (activation) the respondents are before their journey (pre-commute), at the completion of their journey (immediately after journey) and sometime later after the completion of their journey (post commute). They were measured by answering the question, ''How do you feel right now?" and their answers rated on 7-point Likert scales for the two categories measured. This measurement scale was designed based on the Swedish Core Affect Scale (SCAS) which measures core affects, argued to be instrumental for understanding emotions (Friman et al. 2017b). The negative and positive endpoints of the valence scale were defined by three adjectives *very sad, depressed, displeased,* and *pleased, very glad, joyful*, respectively. While the negative and positive endpoints of the activation scale were defined by *very passive, sleepy, dull*, and *awake, lively, very active*, respectively. Furthermore, the results of these mood measures are indicative of a spill-over effect of commuting on the individual (Hennessy 2008; Friman et al. 2017b). The spill-over effects measured would be based on the respondents' attitudes (moods) upon arriving at the workplace and the home (post commute). The single sample t-test analysis is used for the moods at these time intervals because it compares the means in the two groups of valence and activation with a pre-selected value of zero (0) to determine statistical significance (Bryman 2016). Zero (0) is used here because it is the mid-point (neither negative nor positive) of the elements that make up the valence and activation scales. Table 4.24 summarises the results of the findings.

Table 4.24: Mood Responses

Mood	Mean	Std Dev	Std Err	t-value	p-value
Mood I (Pre-Commute) Valence	.326	.937	.023	14.223	0.000
Mood I (Pre-Commute) Activation	.158	1.278	.031	5.034	0.000
Mood II (Immediately after commute) Valence	.506	.901	.028	18.244	0.000
Mood II (Immediately after commute) Activation	.648	1.021	.031	20.624	0.000
Mood III (Post-Commute) Valence	.626	.815	.024	25.326	0.000
Mood III (Post-Commute) Activation	.509	1.073	.033	15.665	0.000

Source: Author's Survey

As regards mood immediately after the journey, table 4.24 shows that the mean valence increased significantly from (M = 0.326) before the journey (mood I) to (M = 0.506) immediately after the commute (mood II). Mean activation also increased significantly from (M = 0.158) before the journey (mood I) to (M = 0.648) immediately after the commute (mood II). This indicates that respondents were on average significantly happier and more active immediately after completing their journey (mood II) when compared to their mood before the start of the journey (mood I).

In terms of mood later after the completion of their journey (mood III), table 4.24 shows that the mean valence increased slightly from (M = 0.506) immediately after their commute (mood II) to (M = 0.626) later at their destination (mood III). Furthermore, when this mood (mood III) is compared to the initial mood before the journey (M = 0.326 – mood I) a significant increase is noticed. This indicates that although respondents are generally more positive at any moment after their journey than before the start, they are happiest later after their commute must have ended (mood III) – in relation to the other time intervals. Conversely, when mean activation is considered, evidence show that the mean activation decreased slightly from (M = 0.648) immediately after their commute (mood II) to (M = 0.509) later at their destination (mood III). However, their mean activation at mood III is a significant increase when compared to their mood before the journey (M = 0.158 – mood I). This indicates that even if respondents become less active later after their commute (mood III) when compared to activeness immediately after the journey (mood II), they still feel significantly more active at this stage than at the start of their journey (mood I).

In sum, evidence from the study show that respondents were at their happiest later after their journey (at mood III) and most active immediately after their journey (at mood II) than at any other points before or after their journey. Furthermore, while they are generally positive all through, their concentration levels drop later at their destination (mood III) resulting in them

becoming less active (more tired) at work and/or home. Moreover, these values are significant at 0.05, hence the assumptions not only apply to the study sample, but to the wider population.

4.10.2 Exploring the impact of Commute Distance and Time on Mood immediately after Commute.

The relationship that exists across respondents' mood immediately after their journey (mood II), the distance travelled, and the time taken to travel is explored in this section. Mood is treated as the response variable (dependent), commute distance and time are the predictor variables (independent). Furthermore, since mood is a categorical scale variable, ordinal logistic regression is used in modelling the results.

Table 4.25: Mood Immediately after Commute, Commute Distance and Commute Time

Mood II (End of Journey)	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Distance (km)	-.037	.013	.964	-2.84	.005	-.062	-.011	***
cut1	*-2.583*	*.134*		*.b*	*.b*	*-2.846*	*-2.32*	
cut2	*-1.017*	*.099*		*.b*	*.b*	*-1.211*	*-.823*	

Mean dependent var	0.608	SD dependent var	0.640
Pseudo r-squared	0.005	Number of obs. (n)	1056
Chi-square	7.949	Prob > chi2	0.005
Akaike crit. (AIC)	1683.030	Bayesian crit. (BIC)	1697.917

Mood II (End of Journey)	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Duration (mins)	-.006	.005	.994	-1.07	.287	-.016	.005	
cut1	*-2.504*	*.166*		*.b*	*.b*	*-2.829*	*-2.18*	
cut2	*-.945*	*.139*		*.b*	*.b*	*-1.218*	*-.672*	

Mean dependent var	0.608	SD dependent var	0.640
Pseudo r-squared	0.001	Number of obs. (n)	1056
Chi-square	1.133	Prob > chi2	0.287
Akaike crit. (AIC)	1689.847	Bayesian crit. (BIC)	1704.733

**** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).

Source: Author's Survey

Table 4.25 shows that a significant relationship exists between commute distance, and respondents' mood immediately after their commute, but not between commute time and respondents' mood immediately after their commute. Regarding commute distance and mood immediately after journey, the output shows that a significant negative relationship exists. The regression coefficient indicates that for every 1 km increase in commute distance, there is a

predicted decrease of 0.037 in the log odds of being on a higher category for the mood variable. Given that the odds ratio is < 1 (0.964), there is a decreasing probability of the respondent being in a higher category for mood as commute distance increase. This means within the study sample and in the general population, the greater the distance travelled for work, the more negative the mood is affected. Also, a negative relationship exists between mood immediately after commute and the commute time for respondents in the study. The regression coefficient indicates that for every 1 min increase in commute time, there is a predicted decrease of 0.006 in the log odds of being in a higher category for the mood variable. Given that the odds ratio is < 1 (0.994), there is a decreasing probability of the respondent being in a higher category for mood as commute time increase. This means within the study sample, the longer the time travelled for work, the more negative the mood is affected (lower journey times improved moods).

4.10.3 Exploring the impact of Commute Distance and Time on Post-Commute Mood

The relationship that exists across respondents' post-commute mood later at their destination (mood III), the distance travelled, and the time taken to travel is explored in this section. Mood is treated as the response variable (dependent), commute distance and time are the predictor variables (independent). Furthermore, since mood is a categorical scale variable, ordinal logistic regression is used in modelling the results.

Table 4.26: Post-Commute Mood, Commute Distance and Commute Time

Mood III (Post Commute)	Coef.	St.Err.	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Distance (km)	-.013	.012	.987	-1.06	.287	-.036	.011	
cut1	*-2.666*	*.144*		*.b*	*.b*	*-2.948*	*-2.383*	
cut2	*-.575*	*.096*		*.b*	*.b*	*-.763*	*-.388*	
Mean dependent var			0.553	SD dependent var			0.622	
Pseudo r-squared			0.001	Number of obs			989	
Chi-square			1.117	Prob > chi2			0.290	
Akaike crit. (AIC)			1672.844	Bayesian crit. (BIC)			1687.534	

Mood III (Post Commute)	Coef.	St.Err	Odds Ratio	t-value	p-value	[95% Conf	Interval]	Sig
Duration (mins)	.008	.003	1.008	2.62	.009	.002	.015	***
cut1	*-2.318*	*.161*		*.b*	*.b*	*-2.633*	*-2.003*	
cut2	*-.221*	*.124*		*.b*	*.b*	*-.464*	*.022*	
Mean dependent var			0.553	SD dependent var			0.622	
Pseudo r-squared			0.004	Number of obs. (n)			989	
Chi-square			7.376	Prob > chi2			0.009	
Akaike crit. (AIC)			1666.585	Bayesian crit. (BIC)			1681.276	

**** p<.01, ** p<.05, * p<.1*

Note: The cut points or threshold parameters in ordered regression models indicate where the latent variable is cut to make the groups that is observed in the data. They are generally not used in the interpretation of results since they have little intuitive appeal (see Williams and Quiroz 2020).
Source: Author's Survey

Table 4.26 shows that a significant relationship exists between commute time and the post-commute mood later, but not between commute distance and the post-commute mood later. A negative relationship exists between the post-commute mood of respondents and the distance travelled. The regression coefficient indicates that for every 1 km increase in commute distance, there is a predicted decrease of 0.013 in the log odds of being on a higher category for the mood variable. Given that the odds ratio is < 1 (0.987), there is a decreasing probability of the respondent being in a higher category for mood as commute distance increase. This means within the study sample, the greater the distance travelled for work, the more negative the mood is affected later at the destination. While a positive significant relationship exists between post-commute mood and commute time for respondents in the study. The regression coefficient indicates that for every 1 min increase in commute time, there is a predicted increase of 0.008 in the log odds of being at a higher category for the mood variable. Given that the odds ratio is > 1 (1.008), there is an increasing probability of the respondent being at a higher category for mood as commute time increases. This means within the study sample and in the general population, the longer the commute time, the better the mood later at the destination (i.e., longer journey times, improved moods).

4.11 Summary

This chapter presented the results of the analysis of the data collected for the WELCOM study. The socio-demographic characteristics, commute patterns / behaviours, and neighbour quality amongst others were analysed using the measures of central tendencies to assess the magnitude, probability, and/or extent of occurrence i.e., frequency and percentages, to better understand any nuance within the population as far as these variables are concerned. Five measurement scales were adopted in the study: a mood scale, the Satisfaction with Travel Scale (STS), the Satisfaction with Life Scale (SWLS), a commuting behaviour scale, and a neighbourhood quality scale. A reliability test was conducted after the descriptive analyses to estimate the internal consistency for each of these scales and determine their relevance and quality to the study. The dimensions of travel satisfaction and well-being were then explored in the context of various determinants such as commute time, commute distance, commute mode and socio-demographic characteristics. Furthermore, commuting behaviour and neighbourhood quality were both explored in the context of travel satisfaction and well-being.

The chapter concluded with the analysis of the spill-over effects commuting has on the individual at three different time intervals, before their commute (mood I), immediately after their commute (mood II) and 90 minutes after their commute (mood III), while also exploring the effects of commute time and commute distance on moods II and III.

CHAPTER 5: DISCUSSION

5.1 Introduction

The research proposed to capture and explain the impacts of commuting on travel satisfaction and well-being positing that there was a relationship across all three. Moreover, the study set about understanding if there were aftermaths to the commute experience. To address this, the study set out to use a temporally dynamic method whereby a novel longitudinal data collection approach was designed and implemented to register commuting patterns, travel satisfaction, mood and well-being of participants. By using repeated observations, it is assumed that the influences of multiple journeys on the commuting experience and life satisfaction would be effectively captured and analysed.

Furthermore, 6 research questions were designed exploring some correlates of commuting, travel satisfaction and well-being. Among these were socio-demographic conditions, neighbourhood quality and accessibility, commuting behaviour, commuting time and commuting distance. Also, these questions informed the research design vis-à-vis the data collection method, the variables to be measured, sampling procedure, and data analysis. The WELCOM study is a culmination of all these. It is an innovative approach designed to capture daily travel-patterns of individuals in Cardiff, elicit their travel satisfaction and its impact on their well-being via a smartphone-based application. This section consolidates the findings of the research, presenting a discourse on how the study proffers answers to the research aim and questions postulated earlier.

5.2 Commuting, Travel Satisfaction and Well-being

Research Questions I, II & V: What role does an individual's satisfaction with daily travel play on their subjective and overall well-being; What role does the individual's commuting characteristics (i.e., commuting time, commute distance mode and commute mode) play on travel satisfaction and subjective well-being; and Is there any association across the individual's commuting behaviour, travel satisfaction and subjective well-being?

In this study, satisfaction with travel represents a positive user experience and this has been shown to contribute to people's well-being. Studies spanning different countries using different methodologies have concluded that ultimately satisfaction from an individual's travel activity contributes to having a high rating for well-being (Abou-Zeid 2009; Ettema et al. 2010; Bergstad et al. 2011; De Vos et al. 2013; Olsson et al. 2013; Nordbakke and Schwanen 2014a;

Zhu et al. 2017). Commuting is a form of travel activity. In fact, majority of the travel activity conducted by individuals are commuting related (Mokhtarian et al. 2001; Redmond and Mokhtarian 2001; Ettema et al. 2010; Kizony et al. 2020). As such, it is expected that the satisfaction with daily travel to work would at some point in people's lives influence the way they evaluate their life satisfaction. Evidence from the WELCOM study shows that a positive (significant) relationship exists between the travel satisfaction of commuters and their well-being. The more people are satisfied with their travel the higher their well-being is expected to be. Numerous studies have also concluded that travel satisfaction play a significant role in explaining well-being (Ettema et al. 2011; Abou-Zeid et al. 2012; Friman et al. 2013; Olsson et al. 2013). This result also suggests the existence of a significant relationship across commuting, travel satisfaction and well-being. Also, the statistical significance of this relationship points to the fact that this phenomenon would likely be noticed in the general population.

5.2.1 Commute Characteristics within Travel Satisfaction Context

It has been suggested that travel satisfaction is influenced by experiences during travel, activities engaged in during travel, the travel duration, travel time and travel mode amongst other things (Choi et al. 2013; De Vos et al. 2013). Findings from the WELCOM study suggests these to be true. Commute statistics from the study shows that the average travel time is 24 mins one-way. This means that on average, commuters within the study spent 48 minutes daily travelling to and from work. In comparison, the average one-way commute time is 26 mins in the United States, 29 mins in the UK, 38 mins in Asia, and 42 mins across the European Union countries (ONS 2014; Chen et al. 2019; Chatterjee et al. 2020). This would indicate that the commuting time in the study area is indeed the best among the other locations, with the regional average from other EU countries being more than twice as bad. However, caution should be taken when making inference because the evidence suggests that commute time does not show a statistical significance with travel satisfaction in the study. Furthermore, there is a cluster of travel satisfaction ratings around the centre of the city and its environs within the study, revealing that most respondents live and/or work not too far off (see figure 4.6) which might influence the lower reported commute time.

Similarly, the average distance travelled by respondents within the study is 5km one-way. By comparison, the UK national average, and average commute distance from Asia are 15km and 13km one-way respectively (Le Vine et al. 2017; Chen et al. 2019). It is obvious that average commute distances from elsewhere triple the commute distance in the study area.

However, the evidence suggests the relationship between travel satisfaction and commute distance is not significant in the study so the results should be interpreted with caution.

The regression analysis indicates a negative relationship between travel satisfaction and commute time. Studies have also been able to show that commute time is negatively associated with travel satisfaction (Olsson et al. 2013; Morris and Guerra 2015a). In addition, within the study area the evidence suggests that the respondents reported lower travel satisfaction ratings the longer the time spent travelling. This is consistent with existing studies suggesting that longer commute times are associated with reduced travel satisfaction (Ory and Mokhtarian 2005; Ettema et al. 2012; St-Louis et al. 2014; Ye and Titheridge 2017).

Also, findings from the WELCOM study indicate that the distance travelled for work is negatively associated with travel satisfaction. Invariably, the longer the distance travelled, the worse the travel satisfaction reported. In support, some studies that have considered the effect of distance on travel satisfaction, all indicating that longer commute distances result in lower travel satisfaction levels (Morris and Guerra 2015a; Zhu and Fan 2018). Although the non-significance of the result points to the fact that the evidence available is not sufficient to conclude that commute distance and commute time negatively affects travel satisfaction within the wider population in Cardiff.

Commute mode has been found to be one of the major determinants of travel satisfaction (Mouratidis et al. 2019). Evidence form the WELCOM study also confirms this. Three models – travel satisfaction and commute time, travel satisfaction and commute distance, and travel satisfaction and commute mode – were run separately and only the model with travel satisfaction and commute mode was statistically significant. This suggests that within the study sample, the commute mode had a significant impact on the travel satisfaction of the respondents. Furthermore, evidence of this would most likely be observed within the larger population in Cardiff.

Car commuters have the second longest commute on average (about 9km) within the study and their journey times are similar to the sample average of about 24 mins. Over the course of the study, car commuters posted the worst travel satisfaction scores, even dropping below the average in the first couple of months – the only travel mode to record negative average monthly scores in terms of travel satisfaction (see Figure 4.5). Commuting can be a major cause of stress due to its unpredictability and perceived loss of control (Roberts et al., 2011). When there is a perceived lack of control over certain elements that can occur during driving, commuting is experienced as more stressful and can lead to lower ratings for travel

satisfaction (Lancée et al. 2017). Also, car commuters' satisfaction with travel can be affected by elements such as traffic congestion, attitudes of other road users, parking availability and duration reliability (Novaco and Gonzalez 2009; Morris and Hirsch 2016) all of which results in a perceived lack of control by car commuters. As a result, car commuters are generally less positive when it comes to travel satisfaction due to them having to remain focussed and alert when environmental stressors are high (Ettema et al. 2013; Morris and Hirsch 2016). This might explain why car commuters reported the worst travel satisfaction rating within the study. Bus commuters journey length is close to the average commute distance at 6km, but they travelled the longest time to work (29 mins). The regression analysis says they are 1.3 times more likely to be satisfied with their journeys than car commuters. This is also reflected in their travel satisfaction scores over time (see Figure 4.4). Train commuters travelled the longest distance (11km) in the shortest time (21 mins). Their commute time is better than the average commute time in the study. In addition, they are 1.4 times more likely to be satisfied with their commutes than car commuters. Within the survey sample, the findings indicate that train commuters are more satisfied with their journeys than bus commuters. This finding is supported by a couple of studies that discovered that bus commuters are less satisfied with their commutes than train commuters (St-Louis et al. 2014; Handy and Thigpen 2019). Although, public transport commuters fared better than car commuters within the survey, they still reported lower levels of travel satisfaction when compared with the remaining commute modes. As the case was with car commuters, there is the possibility that a perceived lack of control over environmental stressors may be the cause for low travel satisfaction ratings among public transport users (Beirão and Cabral 2007; Lancée et al. 2017). Furthermore, with public transport commuters, the way the related service and infrastructure such as cleanliness, comfort, frequency, punctuality and personnel attitudes is seen greatly affects their travel satisfaction rating (De Oña et al. 2013; Van Lierop et al. 2018). For example, 82% of respondents within the study were dissatisfied with the punctuality and frequency of public transport in the city (see table 4.4). It is likely that these factors are at play when travel satisfaction is being reported by public transport commuters within the study area. It is important to note here that public transport is not a significant predictor in the study, hence there is the possibility that this occurrence within the sample was only by chance. Within the study sample, public transport services offered the best and worst journey times on average. This perhaps illustrates the challenges of public transportation in cities generally.

Interestingly, the car and public transport commuter findings from this study goes against the usual convention. The evidence from numerous studies consistently show that car commuters are more satisfied and/or happier than public transit users (Abou-Zeid et al. 2012; Cloutier et al. 2014; Mao et al. 2016; Lancée et al. 2017; Ye and Titheridge 2017). The major reason

posited for car commuters being more satisfied with travel than public transit commuters was that car commuters rated their travel satisfaction based on reference points; the greater the difference in commute time between them and public transport commuters, the more satisfied they are with their commutes (Abou-Zeid et al. 2012). Evidence from the WELCOM study does not substantiate this argument. Since bus commuters have the worst commute times in the study, car commuters should rate their travel satisfaction more positively in comparison. However, train commuters have the best commute times, indicating that car commuters should rate their travel satisfaction more negatively. This again illustrates one of the many challenges public transport delivery poses.

Walk commuters travelled the shortest distance (2km) but have the second worst commute time (27 mins) on average within the study sample. However, they are 2.7 times more likely to be satisfied with their commute than car commuters. This indicates that there are other factors that are at play here. For example, there has been evidence to suggest that feelings of comfort and safety from traffic are associated with reduced commute stress for walking commuters, which in turn improves the travel satisfaction rating reported (Legrain et al. 2015). Cycle commuters travel to work in the shortest time (21 mins) over an average distance of 4km which is the second average commute distance in the study. Also, they are 3.4 times more likely to be satisfied with their travel to work than car commuters which makes them the most satisfied commuter category in the survey. In fact, active commuters generally are the most satisfied commuters within the study and the evidence further suggests that this may be true of the study area due to its statistical significance. There has been consistent evidence showing that active travel (walking and cycling) is associated with higher levels of travel satisfaction than driving and public transit trips (Páez and Whalen 2010; Ettema et al. 2011; Friman et al. 2013; Martin et al. 2014; Chng et al. 2016; Smith 2016). Also, there has been studies reporting that when compared with other commute modes, the lowest levels of stress were found to be among walk or cycle commuters while the highest stress was found amongst car commuters (Gatersleben and Uzzell 2007; Legrain et al. 2015) – evidence of this is seen in the WELCOM study. There is the possibility that because walking and cycling are forms of physical activities, it leads to the release of dopamine which are biologically associated with positive emotions and reduced anxiety, resulting in high levels of travel satisfaction which helps improve the individual's well-being (Penedo and Dahn 2005; Humphreys et al. 2013).

Evidence from the WELCOM study shows that as far as travel satisfaction is concerned, commute mode evaluated from best to worst are as follows: (1) cycle, (2) walk, (3) train, (4) bus, and (5) car. In sum, De Vos (2019) opined that the reason travel satisfaction is different from one commute mode to the other might be because of the extent to which people travelled

with their preferred commute mode. Commuters that can travel with their preferred mode will most likely experience their commute positively hence reporting a high travel satisfaction rating than commuters who are forced to commute with a less desirable mode ultimately ending up not being satisfied with their journey. This is believed to most likely be the case with respondents in the WELCOM study.

5.2.2 Commute Characteristics within Well-being Context

It has been reported that a relationship exists between daily out-of-home trips and well-being (Ettema et al. 2010). This in turn supports the claim that satisfaction with daily travel can positively impact the well-being through facilitating access to daily activities such as work, school, shopping, leisure etc (Bergstad et al. 2011). It has also been suggested that there is an effect of travel satisfaction on well-being, and well-being may also influence ratings of travel satisfaction (Abou-Zeid 2009). This relationship is furthered explored by modelling the interactions between well-being and commute time, well-being and commute distance, and well-being and commute modes. These factors have been shown to influence travel satisfaction both in previous studies and in this study.

The regression analysis indicates that a significant negative relationship exists between the commute time and the well-being of respondents within the study. This statistical significance also indicates that the existence of this relationship would be noticed within the general population in the city. The evidence suggests that the longer it takes to travel for work, the worse commuter well-being is expected to be. Studies have consistently shown this to be true indicative that commute time negatively influences well-being and longer commute time is consistently associated with lower well-being ratings (Stutzer and Frey 2008; Ettema et al. 2011; Choi et al. 2013; ONS 2014; Nie and Sousa-Poza 2018). The WELCOM study findings show similar results. As previously explained, long commutes are associated with negative effects of commuting such as stress, and boredom (Koslowsky et al. 1995; Gatersleben and Uzzell 2007; Novaco and Gonzalez 2009) which ultimately leads to decreased levels of well-being. However, some studies found positive relationships between commute time and well-being. Findings from these studies suggested that some commuters (walking and cycling commuters especially) might enjoy spending more time commuting, hence they are quite satisfied with longer commute times and dissatisfied with shorter commute times (Páez and Whalen 2010; Martin et al. 2014; Lancée et al. 2017).

Conversely, a positive relationship is observed between the commute distance of respondents and their well-being. More importantly, this relationship is seen to be significant, indicative that

this occurrence is not by chance and would most likely be expected within the larger population. This means that the longer the distance travelled for work, the better the reported well-being ratings. As perplexing as this may seem, there are some explanations. In fact, findings from the study show that train commuters who travelled the farthest distances for work have the highest well-being ratings over time (see figure 4.2). A reason longer commutes distances would positively affect well-being ratings may rest on the commute itself. Let us assume that longer commutes have much more unpredictability than shorter commutes. Previous studies have suggested that some of the negative consequences of commuting are most likely expected when there is a perceived lack of control and predictability over commute (Wener et al. 2003; Lancée et al. 2017). Therefore, it can be applied that longer commutes would have little detrimental effects if the commute is perceived as controllable (e.g., reliable train connections). In the same vein, short commutes would exert a negative influence if the commute were perceived as unpredictable (e.g., frequent traffic congestion on the route). Hence, longer commutes being positively associated with well-being. Furthermore, studies have shown activities conducted during commuting can generate a positive effect on the commuter (Mokhtarian and Salomon 2001; Mokhtarian et al. 2001; Ory and Mokhtarian 2005). These studies opined that beyond the obvious purpose of getting to work and vice versa, the time spent commuting can be put to other meaningful uses such as doing some work, social networking, relaxing or enjoying the scenery. Furthermore, the commute can also offer a natural transition between the workplace and the home and vice-versa. Time spent in the car, or on the bus, train, bike or walking, while going to and coming from work can serve as a decompression period for commuters. Some people may even increase commute time to take advantage of these positive utilities of commuting (see positive relationship between commute time and well-being above) (Redmond and Mokhtarian 2001; Ory and Mokhtarian 2005; Páez and Whalen 2010; Lancée et al. 2017). Ultimately, commute distance can have both negative and positive effects on well-being.

Commute mode was also found to be one of the major determinants of well-being in this study, suggesting that within the study sample, the commute mode had a significant impact on the well-being of the respondents. Furthermore, evidence of this would most likely be observed within the larger population in Cardiff.

Although car commuters have the second longest commute distance and their journey times can be summed as average at best, they do not report the worse well-being rating in the study. Nevertheless, the reported well-being from car commuters were still quite poor. Figure 4.5 summarises the well-being of car commuters over the course of the study. Interestingly, the months in which travel satisfaction fell below the average were also the months with the

highest recorded well-being ratings. This is followed by a major dip in well-being ratings before a gradual rise over the next couple of months. Since it has been established that travel satisfaction impacts well-being, this observation might be indicative of a coping mechanism due to adaptation for car commuters. Well-being ratings start off quite high, they experience the worse couple of months in terms of travel, then their well-being ratings drop drastically. Only for them to get used to their related travel issues and their well-being ratings starts to rise. Perhaps, having to cope with the travel stress of long commute distances (second only to train commuters) was a factor for this. Also, the issue with commute predictability explored earlier on might also help to explain the reason for the low well-being ratings for car commuters. Finally, since car commuters posted the worse travel satisfaction reports earlier, they were used as the reference category for assessing well-being by mode in the WELCOM study.

Walk commuters within the study recorded the lowest ratings for well-being ratings. Evidence from the study suggests that walk commuters were 0.9 times less likely to report higher well-being ratings than car commuters. However, this result is statistically non-significant and only holds true for the sample. This is rather surprising because it has been established that active forms of travel ultimately impact well-being positively. This means that other factors (by themselves or a combination of) impact the well-being rating of walk commuters within the study. This is consistent with a UK study which suggested that walking to work was associated with lower ratings for well-being compared to driving for commuters (ONS 2014). The major reason for these British walk commuters' dissatisfaction and reduced well-being levels was the weather conditions. Studies have found that active commuters are more sensitive to weather (temperatures, clouds, precipitation and wind), and weather is found to influence commuters well-being especially during the winter months (St-Louis et al. 2014; Böcker et al. 2016). Considering that the WELCOM study was conducted over the winter season in Cardiff, this might explain why walking commuters reported lower well-being ratings.

The evidence already established that cycling commuters reported the highest rating for travel satisfaction within the study. They also reported high ratings for well-being. It is observed that cycling commuters are 2.3 times more likely to report higher well-being ratings than car commuters within the study. Furthermore, evidence of this may also be found within the wider population since this result is statistically significant. Cycling (and active travel in general) have been consistently shown to be positively associated with higher well-being levels (Páez and Whalen 2010; Humphreys et al. 2013; Martin et al. 2014; Chng et al. 2016). In fact, cycling has been found to have a more positive effect than car or bus travel on the well-being of commuters due to it having some elements of physical activity (Martin et al. 2014; Morris and

Guerra 2015b). These findings suggest that active travel has benefits that extend beyond the travel domain and having direct impacts on well-being aspects of physical and mental health (De Vos 2019).

Although bus commuters reported lower travel satisfaction ratings in comparison to other modes, they do report better well-being ratings than some commute modes. In fact, bus commuters are 1.1 times more likely to report higher well-being ratings than car commuters – albeit this is not significant and only holds true for the sample. Moreover, this finding is corroborated by a similar finding from another study suggesting that the use of public transport mostly results in relatively unsatisfied commuters ultimately leading to lower levels of well-being, especially when using the bus (St-Louis et al. 2014). Despite train commuters reporting average levels of travel satisfaction ratings (in comparison to the other modes) over the course of the study, they reported the highest well-being ratings within the study (see figure 4.2). Evidence suggests that train commuters were 5.1 times more likely to report a higher well-being rating than car commuters. Moreover, this assumption could also be true of the wider population because of the statistical significance. Predictability and perceived control – discussed earlier – can help explain the reason public transport, especially train, is associated with higher ratings for well-being in the study area. If the commute is perceived as controllable, the detrimental effects of a (normally) stressful journey could be mitigated. For example, a study of commuters showed that predictability is associated with reduced stress for rail commuters, possibly because predictability offers a form of cognitive control in situations where commuters do not have behavioural control (Evans and Carrère 1991; Wener and Evans 2011). In this context, cognitive control relates to the commuter's understanding of the situation based on the information available to them, while behavioural control relates to the commuter's perception of what can be done to influence the situation based on the amount of control they have. Furthermore, public transport affords commuters the opportunity to take advantage of some of the positive utilities of commuting such as socializing activities during commutes (e.g., talking to others) and having company and these are positively associated with higher levels of well-being among commuters (Ettema et al. 2012; Olsson et al. 2013).

In sum, evidence from the WELCOM study suggests that as far as well-being is concerned, commute mode evaluated from best to worst are as follows: (1) Train, (2) cycle, (3) bus, (4) car, and (5) walk.

5.2.3 Commuting Behaviour within Travel Satisfaction and Well-being Context

Evidence from the study show that the commuting behaviour of respondents is negatively associated with their travel satisfaction. This implies that the commuting behaviour and attitude of respondents adversely affected their travel satisfaction. Also, since this relationship is found to be statistically significant, it means that evidence of this may be found within the wider city population. On the other hand, when the relationship between commuting behaviour and well-being is considered, findings suggest a positive significant association exists. This means that within the study sample, the commuting behaviour and attitude of respondents positively affected their well-being. Furthermore, evidence of this may be observed in the general population.

It has been observed that factors such as commute characteristics (e.g., commute time and distance) and commute behaviour significantly influence travel satisfaction (Ye and Titheridge 2019). Also, studies have shown that travel satisfaction is linked to travel-related behaviours and attitudes. As such, a positive stance towards certain travel modes would have positive implications for travel satisfaction when using that mode (St-Louis et al. 2014; Ye and Titheridge 2017; De Vos 2019). Similarly, a preference for a mode or an individual's usual commute mode is associated with higher well-being (Handy and Thigpen 2019).

Commuting behaviour and attitudes within the study can be divided into two broad categories based on the results of the descriptive analysis of commuting behaviour (see table 4.4). These categories are related to the respondents' stance towards commuting. They are commuting behaviour related to negative travel opinion and commuting behaviour related to positive travel opinion. A summary of these is provided in table 5.1.

Table 5.1: Commuting Behaviour Categories

S/N	Positive Travel Opinion	Negative Travel Opinion
1	Commute does not make me nervous	Commute is boring
2	Commute is safe	Concern about public transport availability, frequency, and punctuality
3	Commute is a useful transition	Car is a necessity
4	Comfortable with other people	
5	Willingness to change travel behaviour	

Source: Author's Survey

Commuting behaviour that connote negative meaning are most likely going to adversely impact the way the individual view their commute, their travel satisfaction and ultimately their

well-being. Evidence from the WELCOM study indicate that more respondents: thought that their commute was boring, were concerned about public transport availability, frequency and punctuality, and thought the car was a necessity and not a luxury. These negative travel opinions are related to two commute modes, the car and public transport. Studies have shown that the choice of available commute mode greatly determines attitudes towards that mode. Jacques et al. (2013) opined that the overall low levels of attitudes towards – and satisfaction with – public transport suggest that it is within reason to assume a considerable share of public transport users are forced to travel by that means. Therefore, it is most likely that this is the case for respondents within the study, hence their opinion on public transport use. De Vos (2019) further explains that people do not always have a free choice of the travel mode to use. If that was the case, they would most likely choose their preferred travel mode and be satisfied with that. Similarly, car commuters, especially those residing in suburbs or rural areas might not have a free choice of travel options available to them asides from driving (Mattioli 2017). Hence, most of the respondents are of the opinion that their commute is boring, and the car is considered a necessity.

Furthermore, commuting behaviour that represents positive travel opinion from respondents within the study sample could explain the reason a moderate strength positive significant relationship is observed between commuting behaviour and well-being. Table 5.1 indicates that more respondents opined that; commuting does not make them nervous, commuting was safe, they were comfortable with people during their commute, and commuting was a useful transition between home and work, and vice versa. As explained earlier, when individuals take advantage of some of the positive utilities of commuting such as socializing activities during commutes (e.g., talking to others) and having company, the negative impact of commuting is greatly reduced. Also, these positive utilities of commuting are positively associated with higher levels of well-being among commuters (Ettema et al. 2012; Olsson et al. 2013). Hence, it can be assumed that the positive travel opinions from the WELCOM study respondents are synonymous with individuals who have tapped into the positive utilities of travel thereby improving their well-being.

5.3 Socio-demographics, Travel Satisfaction and Well-being

Research Question III: How has the socio-demographic conditions affected the travel satisfaction of individuals, and have these conditions affected their subjective well-being?

Studies have shown that the socio-economic characteristics of individuals do determine how satisfied they are with their chosen travel mode and how they evaluate their lives in general (Dolan et al. 2008; Gao et al. 2017a; Ma et al. 2018; Ingenfeld et al. 2019; Wu et al. 2019). Having understood the relationship across commuting, travel satisfaction and well-being, the WELCOM study attempts to understand the relationship people's socio-demographic characteristics play on their satisfaction with daily commute and well-being. An analysis of the influence of the commute characteristics (time, distance and mode) on travel satisfaction and well-being was first conducted. The evidence suggested commute mode to be the strongest determinant of travel satisfaction and well-being. Using this best fit metric, the study thus explored the relationship between different socio-demographic characteristics, travel satisfaction and well-being while controlling for other socio-demographic characteristics and commute mode.

5.3.1 Socio-demographics and Travel Satisfaction

The findings from this study reveal that the socio-demographic characteristics significantly influenced the travel satisfaction within the study sample. Also, evidence of this relationship may be observed within the general population because of the statistical significance of the relationship.

Within the study sample, there is a high proportion of female respondents as compared to male respondents. In fact, women outnumber men 2:1 within the survey. It is no surprise then that the findings suggest gender was not a significant predictor for travel satisfaction within the general population. A recent study of willingness to participate in alternate data collection mode discovered that women are more likely to participate in e-mail surveys (Mulder and de Bruijne 2019). Since most of the study invites were sent out via e-mail, this would explain the gender bias observed in the WELCOM study. When gender is considered along with travel satisfaction, the findings reveal men are more likely to report higher travel satisfaction ratings. Within the study sample, active commuters reported the highest travel satisfaction ratings while car commuters reported the worst. More men reported observations for active commuting modes (walking and cycling) and most of the observations for car journeys was by women. This may partially explain the reason this relationship exists. Moreover, studies have

discovered that although women tend to commute less, they are more influenced by the negative effects of commuting than men (Wener et al. 2005; Roberts et al. 2011). It is possible that because women have greater responsibilities outside their work for household chores, commuting is viewed as a competing demand on a their time and thus a greater psychological burden (Novaco et al. 1991). Thus explaining why women are more likely to report lower travel satisfaction ratings than men.

Although age is not a significant predictor of travel satisfaction for the wider population, the study observed the occurrence of mixed associations between age and travel satisfaction amongst respondents. Generally, older respondents were more likely to report higher travel satisfaction ratings than younger respondents but for the exception of two age categories. Respondents between 40 and 45 years old, and respondents 50 years and above were less likely to report higher travel satisfaction rating. Similarly, older people have been found to be more satisfied with their commute than younger people (Bergstad et al. 2011; Gao et al. 2017b). Nevertheless, Dolan et al. (2008) observed that age has a U-shaped relationship, with its lowest point in the middle age. Within the study sample, respondents in the age category of 40-45 years old and those aged 50 and above conveniently fall within this middle age category for lower satisfaction ratings as reported by Dolan and his colleagues.

Income also shows mixed associations with travel satisfaction within the study sample. Again, it should be reiterated that income is not a significant predictor for travel satisfaction within the wider population. Generally, a positive relationship is observed between respondents' income and their travel satisfaction. However, respondents earning between £20,000-£36,399 and over £78,000 showed a negative association with travel satisfaction. In other words, the higher your annual income, the more likely you are to report higher levels of travel satisfaction barring those two income categories. In a similar vein, Ye and Titheridge (2019) discovered that lower income respondents reported lower levels of travel satisfaction. And an explanation for this is that lower income earners are more likely to live in accommodations farther away from their work, thereby having to commute longer distances, spend more in transport costs, and may have fewer transport mode choices (Choi et al. 2013). Perhaps, the best explanation for respondents in the highest wage bracket reporting lower travel satisfaction ratings can be gleaned from Dolan and his colleagues. They suggested that higher income levels have a positive effect on satisfaction, but this effect seem to diminish at higher levels of income (Dolan et al. 2008; Easterlin 2010).

The number of people living in the household indicates a positive association with travel satisfaction. The evidence suggests that people who lived in larger households are likely to

report higher travel satisfaction ratings. Studies have indicated that social isolation and boredom can be a major determinant for commute stress which results in decreased levels of travel satisfaction (Koslowsky et al. 1995; Gatersleben and Uzzell 2007; Novaco and Gonzalez 2009). Therefore, having company during the commute could add positively to the satisfaction with the commute mode (Ettema et al. 2012; Lancée et al. 2017). So, respondents who live in larger households would most likely benefit from these positives due to them commuting with other members of their household whether for work or school. Furthermore, the positive travel opinion from respondents' commuting behaviour and attitude within the study sample (see table 5.1) indicates that more people thought that; commuting does not make them nervous, felt commuting was safe, were comfortable with people during their commute, and commuting was a useful transition between home and work, and vice versa. As explained earlier, when individuals tap into the positive utilities of commute, the negative impact of commuting tends to be negated. These travel opinions from the WELCOM study respondents are synonymous with individuals who have tapped into the positive utility of travel (i.e., having company in this case). Again, this characteristic is not a significant predictor of travel satisfaction when controlled for other socio-demographic characteristics and commute mode.

There is a negative relationship between the number of cars in the household and travel satisfaction. The results indicates that people who lived in households with fewer cars are more likely to report higher travel satisfaction ratings. Evidence from the WELCOM study show that respondents who used active commuting modes reported the highest travel satisfaction ratings in the study. And studies have consistently shown that the high ratings for travel satisfaction among active commuters is most likely because they may enjoy the physical activity walking or cycling entail, or they enjoyed the commute in itself (preference) (Redmond and Mokhtarian 2001; Páez and Whalen 2010; Humphreys et al. 2013; Martin et al. 2014). Also, people might take up active commuting due to budget constraints or simply because that was the most cost-friendly solution available to them (Zhu and Fan 2018; Ye and Titheridge 2019). Therefore, it is possible that due to these factors (or a combination of), commuters with few cars within the study were more likely to report higher travel satisfaction ratings.

The results indicates that while the socio-demographic characteristics of respondents by themselves do not significantly predict satisfaction with daily commute within the city, these factors acting together significantly influence travel satisfaction within the study sample and in the wider area context while controlling for commute mode.

5.3.2 Socio-demographics and Well-being

The evidence suggests that the socio-demographic characteristics of the respondents do have a significant influence on their well-being. In fact, it can be argued that socio-demographic characteristics is a major predictor of well-being ratings within the study sample and to some extent in the wider population. Except for gender, the evidence suggests all the selected socio-demographic characteristics show a statistical significance when controlled for other socio-demographic characteristics and commute mode.

Within the study sample, women are more likely to report higher ratings for well-being than men. This finding suggests a complete opposite relationship to the result for gender and travel satisfaction earlier. To start with, women greatly outnumber men in the study, so gender-based analyses would be skewed towards women as noted while discussing gender and travel satisfaction. Moreover, train commuters elicited the highest well-being rating, and women provided almost all observations for this mode. This may explain the reason for this finding. However, it should be noted that gender is not a significant predictor of well-being, so the study errs on the side of caution here. Furthermore, other studies have also found that women reported higher well-being levels than men (Dolan et al. 2008; Friman et al. 2017a). Inglehart (2002) opined that despite women's continuing disadvantages they show higher levels of well-being than men because the global push for gender equality constantly help improve their achievements and help raise their aspiration levels. Since, striving to be the best version of oneself is one of the major tenets of (eudaimonia) well-being this may explain why women report higher well-being ratings than men.

The study finds that age is a significant predictor of well-being within the study. The evidence suggests a negative relationship with the reference category when well-being is compared across the different age groups after controlling for other socio-demographic characteristics and commute mode. And just as it was discovered with travel satisfaction, the respondents within the 40–45-year-old age category are worse off when compared to the reference category of the youngest age category (< 30 years old). Furthermore, evidence suggests that as you move from one age category to the next higher category, negative well-being ratings become worse, peaking at the 40-45 age category (mid-life) before tapering down as you move to the oldest age category. It has been suggested that age seems to have a U-shaped relationship with well-being and higher levels of well-being is associated with not being in middle age (Dolan et al. 2008). Similarly, another UK study discovered that age is correlated with well-being, and middle-aged people were more likely to express lower levels of well-being compared with the young and the elderly (Blanchflower and Oswald 2004). A particular reason

for this is that family life, work life, and other responsibilities tend to take their toll, and individuals may feel a deep sense of remorse for goals that have yet to be accomplished around this point in their lives (Sheehy 2011; Stern et al. 2015). However, while other age categories show a statistical significance, the 40-45 age group is not significant. This means that while the assumption is true of the study sample, there is not enough evidence to suggest it's occurrence within the general population.

A positive significant relationship exists between income and well-being when controlled for other socio-demographic variables and commute mode. Perhaps the most interesting finding from income suggest that respondents who earned between £52,000 and £77,999 are the most satisfied with their lives and are likely to report the highest levels of well-being rating. This is interesting because a couple of studies have discovered that an annual income of $75,000 (£59,000) is the 'salary sweet spot' where the benefits of income on well-being are fully satiated and beyond this is a downward trajectory (Kahneman and Deaton 2010; Dolan 2019). Evidence from the WELCOM study seems to corroborate the 'salary sweet spot' assumption. Moreover, the statistical significance of this predictor would indicate that there is a strong likelihood that this assumption is true for the wider population. Buttressing the point, a UK study attributed the positive correlation between income and well-being within the population to the fact that people with more economic resources would have a greater ability to fulfil their needs (Blanchflower and Oswald 2004). Conversely, lower income earners tend to have relatively fewer travel options, and are more likely to experience transport poverty, which may limit their involvement in social activities, work or education opportunities, healthcare access etc., thereby reducing their well-being (Currie et al. 2010).

The number of people in the household is also found to be a significant predictor of well-being within the study. Evidence points to the existence of a negative relationship demonstrating that respondents who reside in households with more people are likely to report lower levels of well-being. The most plausible explanation for people living in households with more people reporting lower levels of well-being has to do with overcrowding. Households with lower income are more likely to be overcrowded and this can be a source of psychological distress (Watson et al. 2019; Tinson 2020). Furthermore, overcrowding can be stressful on family relationships, reduce privacy and limit the space for children to study or play (Tinson 2020).

The number of cars in the household show a significant positive relationship with the well-being ratings of the respondent while controlling for other socio-demographic factors and commute mode. The evidence suggests that respondents who live in households with more cars are more likely to report a higher level of well-being. Studies have shown that there is a

sense of pride and freedom from owing vehicles – this is because owning a vehicle provides access to a preferred travel mode, improving the individual's capacity to be mobile and ultimately raising their levels of well-being (Kaufmann et al. 2004; Ettema et al. 2010; Delbosc and Currie 2011; McCarthy and Habib 2018). In addition, motility (travel mobility) can be important in satisfying inherent psychosocial needs, such as social participation and inclusion which are deemed necessary for good well-being (Nordbakke and Schwanen 2014a).

The results indicates that the socio-demographic characteristics of respondents certainly influence their well-being while controlling for commute mode. Income appears to play a central role in relation to other socio-demographic characteristics but earning more does not necessarily translate to better well-being. These socio-demographic characteristics are also statistically significant meaning that their occurrence within the sample is not by chance and evidence of these may be observed within the wider population.

5.4 Commuting and Neighbourhood Quality

Research Question VI: How has access to basic amenities, a good neighbourhood, and urban transportation infrastructure and resources influenced commuting patterns and behaviours?

The finding show that a moderate strength positive significant relationship can be observed between commuting behaviour and neighbourhood quality. This indicates that there is the possibility that living in a higher quality neighbourhood positively affects commuting behaviour within the study. The statistical significance of this relationship also indicates that this occurrence is not by chance and there is a strong likelihood evidence of this could be noticed within the wider population. Furthermore, when the relationship across neighbourhood quality, travel satisfaction and well-being is observed, the findings indicate that neighbourhood quality positively influences travel satisfaction and well-being within the study. However, only the relationship between neighbourhood quality and well-being is statistically significant. This indicates that there is the likelihood of this relationship occurring within the wider population. There has been evidence to support that well-being can be affected by the neighbourhood in which one lives (McCarthy and Habib 2018). Other findings have suggested that the higher the accessibility to services, facilities, public transport, and green space, the higher the travel satisfaction (Dong et al. 2016; Feng et al. 2018). Furthermore, the neighbourhood characteristics play an important role in travel satisfaction by significantly affecting commute distance, commute duration, and commute mode choice (Ye and Titheridge 2017; Mouratidis et al. 2019).

In monocentric cities such as Cardiff, residential distance to the city centre has been found to exert particularly strong influences on commuting distance and the distance travelled by car for commuting (Næss et al. 2019). Similarly, Mouratidis et al. (2019) opined that since the destinations of most commute trips in cities are outside the residential neighbourhood, the overall commute distances are therefore likely to be influenced more by how far the home is located to work destinations. It is thus argued that since car commuters within Cardiff registered the worst travel satisfaction, poor ratings for well-being, and the second worst commute times, it can be inferred that the longer distances travelled for work along with the other issues of unpredictability and lack of control identified earlier contributes to make car commutes undesirable.

Evidence from studies on the neighbourhood characteristics and commuting attitudes indicate that accessibility to a park, open field, or green spaces is positively related to higher levels of well-being. The improved levels of well-being experienced is brought about by the ease of access to these amenities for recreation, or perhaps a shorter distance to a park is a signal of some other positive neighbourhood quality (Ambrey and Fleming 2014; McCarthy and Habib 2018). The findings from the WELCOM study suggests that when respondents were asked how satisfied they were with their neighbourhood, a great number of people were satisfied with their accessibility to a park for relaxation or exercise (see table 4.3). This might help explain the positive relationship observed between neighbourhood quality and well-being.

It has been reported that neighbourhood characteristics such as access to shops, medical services, and a satisfaction to perceived residential safety contributes to the residents' evaluation of their well-being (Morrison 2011; Wu et al. 2019). Evidence from the WELCOM study suggests that more respondents were satisfied with these aforementioned neighbourhood characteristics in comparison to respondents who were not. In fact, for some of these characteristics, the ratio of respondents who were satisfied outnumber dissatisfied respondents 8:1. This may also help explain the positive relationship between neighbourhood quality and well-being.

Finally, evidence from the WELCOM study indicates that as far as travel satisfaction is concerned, commute modes evaluated from best to worst are as follows: (1) cycle, (2) walk, (3) train, (4) bus, and (5) car. When travel satisfaction ratings within the city is mapped (see figure 4.6) a large cluster of travel satisfaction is noticed within the city centre and its environs. This might indicate that active commuters live and/or work closer to the city centre, therefore, walk or cycling is a more practicable option which ultimately results in their higher travel

satisfaction ratings. While car commuters could have been coming from residential neighbourhoods farther away making it inconvenient to walk or cycle.

5.5 Commuting and Mood

Research Question IV: What role has the individual's commute experience played on their moods?

As mentioned earlier, three mood measures were employed to capture the emotional well-being of respondents in the WELCOM study. These measurements were collected at three intervals during the commute: mood I – just before the commute start, mood II – immediately after the commute, and mood III – 90 minutes after mood II and were a measure of how happy (valence) or how alert (activation) the respondents were at those time intervals. Essentially, the results of moods (II and III) when compared with each other and with mood I are indicative of any spill-over effect the commuting experience might have on the individual (Hennessy 2008; Friman et al. 2017b).

Regarding mood II – immediately after commute, the findings suggests that happiness increased substantially immediately after the commute when compared with happiness before the commute. Also, alertness saw a massive increase after the commute when compared with alertness before the commute. This suggests that respondents were significantly happier and more alert immediately after their commute than at the beginning of their commute. Since these measures are statistically significant, the probability of their occurrence within the population is reasonably high. Furthermore, commute distance shows a significant negative relationship with the mood immediately after the journey. This means that the longer the distance travelled for work, the more negative mood is immediately after the journey. In addition, commute time also show a negative relationship with mood immediately after the journey albeit a non-significant one. This means that lower commute times would result in improved moods within the study sample, but not in the wider population. Studies have consistently shown that longer commute distance and time were associated with lower positive affect at work and a reduced time sleeping at home (Morris and Zhou 2018; Nie and Sousa-Poza 2018).

In regard to mood III – 90 minutes after the commute, evidence suggests that happiness increased slightly from their levels immediately after the commute and massively from their levels before the commute. This means that even though respondents were generally positive at any moment before and after their commute, they were most happy 90 minutes after their

commute ended. Alertness, on the other hand, showed a slight decrease 90 minutes after the commute when compared with alertness immediately after the commute. However, alertness 90 minutes after the commute still showed a significant increase when compared to alertness at the beginning of the commute. This shows that even if respondents become slightly tired 90 minutes after their commute, they are considerably more alert at this stage than they were at the beginning of their commute. Also, a negative relationship can be observed between commute distance and mood 90 minutes after the commute. This indicates that within the study sample, the greater the distance travelled for work, the more negative mood is affected 90 minutes after the commute at the destination. Studies have consistently shown that longer commute distance are associated with less time spent with spouse, children and friends (Christian 2012). Furthermore, findings from another study showed that longer commutes distance is associated with a worsened mood later in the destination although not immediately after the commute (Friman et al. 2017b). This is consistent with findings from the WELCOM study which indicates that mood (in terms of activation: alertness) worsens 90 minutes after the commute.

Conversely, a positive significant relationship exists between commute time and mood 90 minutes after the commute. This means that the longer the commute time, the better the mood 90 minutes after the commute. This indicates that the positive utilities of commute experience may be a factor for this occurrence. The respondents' positive travel opinion shows that majority of them see the time spent commuting as a useful transition between home and work and vice-versa. Therefore, there is the possibility that commuting might be viewed as a gift rather than a curse and some people would even want to have longer commuting times to be able to use the travel time productively and prepare for the demands of the destination (Redmond and Mokhtarian 2001; Jain and Lyons 2008).

These results simply mean that respondents were most happy 90 minutes after their commutes and most alert immediately after their commutes than at any other moment before or after their commute. Furthermore, the results also show that respondents were generally positive all through. This is consistent with findings from a similar research arguing that mood is positive on average (Diener et al. 2015). And their concentration levels drop later at their destination resulting in them becoming slightly less alert (or more tired) at work or home.

5.6 Reflections on Conceptual Framework considering the WELCOM Study Results

In conducting the WELCOM study, the researcher was guided by a conceptual framework gleaned from the review of several literature. This conceptual framework shaped both the methodology adopted in the survey exercise and the analysis of the data collected. This section reflects on the findings of the WELCOM study in the light of its conceptual framework. To start with, it is assumed that individuals can experience positive and negative feelings during the cause of their daily travel which will affect their moods / emotions and the evaluation of their journey. Furthermore, activities undertaken during the course of an individual's daily travel (e.g listening to music, socialising with other passengers, etc.) can affect the feelings experiences during the journey, thus resulting in a relationship between travel satisfaction and overall well-being through the subjective experience of well-being (Ettema et al. 2010; Abou-Zeid et al. 2012; Ettema et al. 2012). As such, it is presumed that travel satisfaction feeds into subjective well-being, which in turn feeds into overall well-being (life satisfaction). There is evidence from the WELCOM study that suggests a statistically significant positive relationship exists between the travel satisfaction experienced by respondents and their level of well-being. In essence, within the study sample and in the general population, the more satisfied one is with their travel, the higher their well-being ratings is expected to be. This evidence therefore substantiates the assumption of a relationship between travel satisfaction and well-being.

However, to understand the positive and negative feelings experienced by commuters during their journey, there is need to critically examine the findings from the study. As regards travel satisfaction, the findings from the WELCOM study indicates a negative relationship between travel satisfaction and commute time. This evidence suggests that the respondents reported lower travel satisfaction ratings the longer the time spent travelling. Furthermore, findings also indicate that the distance travelled for work is negatively associated with the travel satisfaction reported by respondents – i.e., the longer the distance travelled, the worse the travel satisfaction reported. When it comes to well-being, the evidence indicates that a significant negative relationship exists between the commute time and the well-being of respondents within the study. This suggests that the longer it takes to travel for work, the worse commuter well-being is expected to be. Also, longer commutes are associated with negative effects of commuting such as stress, and boredom which ultimately leads to decreased levels of well-being. To buttress this point, studies have consistently shown this to be true, indicative that longer commute time negatively influences travel satisfaction and well-being, and longer commute time is consistently associated with lower travel satisfaction and well-being rating (Stutzer and Frey 2008; Novaco and Gonzalez 2009; Ettema et al. 2011; Choi et al. 2013). Conversely, the findings from the WELCOM study indicates the existence of a positive

relationship between commute distance and well-being. Findings from studies have suggested that some commuters might enjoy longer commutes, hence they are quite satisfied with longer commute times and dissatisfied with shorter commute times especially when there is a perceived element of control and predictability over the journey (Páez and Whalen 2010; Martin et al. 2014; Lancée et al. 2017). Furthermore, the time spent in commute can be put to meaningful use and offer some form of positive utility to the commuter (e.g., offering a natural transition between the workplace and the home and vice-versa, or time spent engaging in social interactions, etc.) (Redmond and Mokhtarian 2001; Ory and Mokhtarian 2005; Páez and Whalen 2010; Lancée et al. 2017). From the foregoing, there is evidence from the WELCOM study that suggests that individuals can (and do) experience positive and/or negative emotions during their journeys which influence the evaluation of their travel satisfaction and also have an effect on their well-being.

Furthermore, the review of literature suggests that following from the spill-over effects of travel and travel satisfaction, a reverse relationship might ensue between travel satisfaction and overall well-being (life satisfaction). One in which the individual's perceived level of travel satisfaction might have an effect on their overall well-being (life satisfaction), and another where the overall well-being of the individual affects their perceived travel satisfaction (Diener 2000,2009). There is evidence from the WELCOM study indicative of the fact that commute distance shows a significant negative relationship with the mood immediately after the journey. This means that the longer the distance travelled for work, the more negative the mood is immediately after the journey. Since evidence from the WELCOM study already show that longer commute distances result in worse travel satisfaction reports, we can conclude that there is enough evidence to suggest that the spill-over effects of travel satisfaction do influence the travel satisfaction and overall well-being of respondents. This is also supported in the literature, where studies have consistently shown that longer commute distance and time were associated with lower positive affect at work and a reduced time sleeping at home (Morris and Zhou 2018; Nie and Sousa-Poza 2018). Also, a negative relationship can be observed between commute distance and mood 90 minutes after the commute. This indicates that within the study sample, the greater the distance travelled for work, the more negative the mood is affected 90 minutes after the commute at the destination. Contrarily, a positive significant relationship exists between the commute time and mood 90 minutes after the commute. This suggests that the longer the commute time, the better the mood is 90 minutes after the commute. This is indicative of the massive role that the positive utilities of the commute experience play on the mood, travel satisfaction and well-being of the respondents. Furthermore, there is evidence from the WELCOM study that suggests that the respondents' positive travel opinion shows that majority of them see the time spent commuting as a useful

transition between home and work and vice-versa, which would explain the reason for this positive relationship. In essence, there is ample evidence from the WELCOM study to suggest that a relationship exists between the travel satisfaction and well-being of respondents through their experienced moods / feelings during, immediate after and later on at the destination.

Having established the relationship across commute characteristics (commute attitude, commute distance and commute time), with mood, travel satisfaction, subjective and overall-well-being, an examination of the influence of socio-demographic characteristics on travel satisfaction and well-being is undertaken. Studies have shown that the socio-demographic characteristics of individuals do determine how satisfied they are with their chosen travel mode and how they evaluate their lives in general (Dolan et al. 2008; Gao et al. 2017a; Ma et al. 2018; Ingenfeld et al. 2019; Wu et al. 2019). The WELCOM study findings reveal that the socio-demographic characteristics of respondents significantly influenced their travel satisfaction. Furthermore, the socio-demographic characteristics is a major predictor of well-being ratings of the respondents, and their income appears to play a central role in relation to other socio-demographic characteristics. However, earning more does not necessarily translate to better well-being.

Perhaps, one other highlight to report when examining the relationship that socio-demographics have on the respondents' travel satisfaction and well-being is the paradoxical assumption that fewer cars in the household results in higher levels of travel satisfaction and lower well-being ratings. The evidence suggests that there is a negative relationship between the number of cars in the household and travel satisfaction. The results indicates that people who lived in households with fewer cars are more likely to report higher travel satisfaction ratings. This is contrary to the norm whereby it is expected that households with fewer cars would be more likely to report lower travel satisfaction due to their poor accessibility to cars (Stanley et al. 2010; Stanley et al. 2011; Delbosc and Currie 2012). However, evidence from the WELCOM study already suggest that respondents who used active commuting modes reported the highest travel satisfaction ratings in the study. And studies have consistently shown that the high ratings for travel satisfaction among active commuters is most likely because they may enjoy the physical activity walking or cycling entail, or they enjoyed the commute in itself (Redmond and Mokhtarian 2001; Páez and Whalen 2010; Humphreys et al. 2013; Martin et al. 2014). Also, some studies have shown that people might take up active commuting due to budget constraints or simply because it was the most cost-friendly travel mode available to them (Zhu and Fan 2018; Ye and Titheridge 2019). Therefore, it is possible that due to these factors (or a combination of these factors), commuters with fewer cars within the study were more likely to report higher travel satisfaction ratings. Conversely, results from

the WELCOM study also reveal that the number of cars in the household show a significant positive relationship with the well-being ratings of the respondents. The evidence suggests that respondents who live in households with more cars are more likely to report a higher level of well-being. Studies have shown that there is a sense of pride and freedom from owing vehicles – this is because owning a vehicle provides access to a preferred travel mode, improving the individual's capacity to be mobile and ultimately raising their levels of well-being (Kaufmann et al. 2004; Ettema et al. 2010; Delbosc and Currie 2011; McCarthy and Habib 2018). In addition, motility (capacity to be mobile) can be important in satisfying inherent psychosocial needs, such as social participation and inclusion which are deemed necessary for good well-being (Stanley et al. 2010; Nordbakke and Schwanen 2014a).

5.7 Summary of Key Findings

The findings from the study suggests that the determinants for travel satisfaction and well-being in the study were commute time, commute distance, commute mode, socio-demographic characteristics, commuting attitudes and behaviours, and neighbourhood quality. To start with, evidence from the study indicates that a positive (significant) relationship exists between the travel satisfaction of commuters and their well-being. The more people are satisfied with their travel the higher their well-being is expected to be. Furthermore, the existence of a significant relationship across commuting, travel satisfaction and well-being was identified – a result that was also statistically significant. Commute statistics from the study indicates that on average, commuters within the study spent 48 minutes daily travelling to and from work; the average distance travelled by respondents within the study is 5km one-way; and most respondents live and/or work not too far away from the city centre. Regarding commute time, the evidence suggests that respondents reported lower travel satisfaction ratings the longer the commute time – although commute time was not a significant predictor for travel satisfaction. Also, the evidence suggests that the longer it takes to travel for work, the worse commuter well-being is expected to be – however commute time was a significant predictor for well-being. In terms of commute distance, the evidence suggests that the longer the distance travelled, the worse the travel satisfaction reported – again, commute distance was not a significant predictor for travel satisfaction. Conversely, the evidence suggests the longer the distance travelled for work, the better the reported well-being rating of respondents – and this relationship is statistically significant.

Commute mode had a significant impact on the travel satisfaction of the respondents within the study. Evidence shows that as far as travel satisfaction is concerned, commute mode evaluated from best to worst are as follows: (1) cycle, (2) walk, (3) train, (4) bus, and (5) car.

Commute mode was also found to have a significant impact on the well-being of the respondents within the study. The findings indicate that in the context of well-being, commute mode evaluated from best to worst are as follows: (1) Train, (2) cycle, (3) bus, (4) car, and (5) walk. Evidence from the study show that the commuting behaviour of respondents is negatively associated with their travel satisfaction – and this is statistically significant. However, a positive significant association is observed between the respondents' commuting behaviour and their well-being.

The findings reveal that the socio-demographic characteristics of the respondents (as a whole) significantly influenced their travel satisfaction while controlling for commute mode. However, these characteristics on their own do not provide any statistical significance with travel satisfaction. Similarly, the socio-demographic characteristics of the respondents do have a significant influence on their well-being while controlling for commute mode. Income appears to play a central role in relation to other socio-demographic characteristics but earning more does not necessarily translate to better well-being. Also, a car use paradox was noticed regarding the number of cars in the household, travel satisfaction and well-being.

With regards to commuting behaviour and neighbourhood quality, the evidence indicates that there is the possibility that living in a higher quality neighbourhood positively affects commuting behaviour within the study – and this relationship is statistically significant. Furthermore, when the relationship across neighbourhood quality, travel satisfaction and well-being is observed, the findings indicate that neighbourhood quality positively influences both travel satisfaction and well-being within the study. However, only the relationship between neighbourhood quality and well-being is statistically significant.

In terms of moods, findings from the analysis of the spill-over effects caused by the commute experience suggests that respondents were most happy 90 minutes after their commutes ended and most alert immediately after their commutes than at any other moment before or after. Furthermore, while respondents are generally positive all through, their concentration levels drop later at their destination resulting in them becoming less active (more tired) at work and/or home. Moreover, these results were statistically significant, hence the assumptions may not only be applicable to the study sample, but also to the wider population.

CHAPTER 6: CONCLUSION

6.1 Introduction

It has been observed that many international organisations have begun adopting measures of well-being to indicate development in their regions at both local and national levels complementing existing measures for economic development and growth (Chen et al. 2019). In fact, the UN Sustainable Development Solutions Network (SDSN) has published a global "Happiness Report" every year since its inception in 2012 (SDSN 2021). This trend of using well-being as a measure of economic development is consistent with the growing evidence that people who consistently rated highly for well-being are equally more satisfied across other domains such as family-life, work-life, social relationships and physical and mental health amongst others (Dolan et al. 2008; Dolan 2019).

In the transport sector, objective impacts of transportation such as travel time, travel costs, accidents, and environmental degradation has been the previous convention when it comes to accessing transportation services impacts on the lives of people (Delbosc 2012). However, there is the growing evidence that the subjective experience of travel via satisfaction with travel influences people's travel attitudes, their travel mode choices and their well-being in general. This not only have important implications for improving transport services and delivery, but also stimulating economic activities and promoting well-being (St-Louis et al. 2014; Gao et al. 2017a). It is therefore encouraged that policy makers complement the existing objective indices on travel with its subjective indices.

6.2 Implications to Policy and Research

6.2.1 Research Implications to Theory and Methodology

To start with, this study is one of the first of its kind to employ a longitudinal approach to investigating travel satisfaction and well-being. Therefore, it plays a role in contributing to the existing methodological approach in travel and well-being literature. A novel data collection technique was designed to collect repeated measures for travel satisfaction and well-being within the study area. Using this approach, the study was able to analyse, the influence of multiple satisfying (and dissatisfying) journeys over time on commuters' evaluation of their overall well-being. This is because it is assumed that the overall well-being can be influenced by the accumulated effects of other domain-specific activities, and in this case, daily travel to and/from work (Ettema et al. 2010; De Vos et al. 2013). This has been previously considered

rather difficult to achieve because of the additional burden it would put on participants, and the actual execution of a multi-day online measurement approach amongst other things. Furthermore, because the measurements were designed to be collected in real-time, this eliminated data collection issues such as recollection/memory bias. Commuters will generally be more likely to accurately recall the journey if measurements are reported immediately after (Friman et al. 2017a).

The collection tool encountered some initial issues – just like any first-generation tool/product. However, as a proof-of-concept, the study demonstrates that this approach to data collection for travel satisfaction and well-being research is feasible. Also, because of the interdisciplinary nature of the concepts being discussed, this proof-of-concept study situates in a new area of research that cuts across transport, geography, psychology and data science facilitating its contribution to methodology across these fields. Finally, this study could also a useful template for developing a panel-data collection design for collecting travel and well-being information on a long-term basis. This does not only have positive ramifications for academic research, but also policy research into travel and well-being.

6.2.2 Research Implications to Policy

The findings from this study have major implications for policy and governance especially in terms of transportation planning within Cardiff and the wider city region. Since the study has effectively established a connection between commuting and well-being, the implications of this research to planning policy cannot be overemphasized. It goes without saying that an effective and efficient transport would have a significant impact on the physical and mental well-being of the population and serve as an impetus for economic development within the region.

Commute time and commute distance being negatively associated with travel satisfaction and well-being calls for policies that promote mixed uses in urban spaces, and transit-oriented development to reduce the total time spent commuting (especially for bus commuters who have the worst commute times) in the city thereby enhancing travel satisfaction and well-being. Furthermore, if anything positive has been learnt from the global pandemic, it is that most people could still carry on with their jobs simply by switching to working from home. And in the case where that is not possible, some organisations have found a way of rotating staff to come in to work on alternate days. Policies that would promote these measures would go a long way to reducing the need to commute regularly and that would improve the well-being of some commuters.

Traditionally, urban planners have touted jobs-housing balance as a panacea for solving urban congestion and longer commute problems, even if it has its flaws (Cervero 1989; Giuliano 1991). However, the basic tenet of the concept assumes that people will choose to work as close to their homes as possible, or they would opt to live as close to their jobs as possible. So, if an area has a larger proportion of employment workers to residing workers, then workers must be sourced from outside the area, which would lead to longer commutes. With Cardiff looking to embrace regionalism and attract more jobs, the centre of the city where a lot of employment is located would see more activity. This would mean longer commute for employment workers being sourced from outside, and longer commutes for resident workers who would be pushed further out (for more affordable housing as rental values increases). Job-housing balance might help ease the burden here as it would mean jobs would be sited closer to people who reside farther away. In addition, studies have shown that longer commutes are associated with some negative consequences of commuting such as stress, and boredom which ultimately leads to decreased levels of well-being (Gatersleben and Uzzell 2007; Novaco and Gonzalez 2009). These negative effects are most likely expected when there is a perceived lack of control and predictability over commute (Wener et al. 2003; Lancée et al. 2017). Therefore, policies that help commuters perceive their journeys as controllable and promote the positive utility of commuting should be prioritized.

Active commuters are the most satisfied commuters in the study. These findings support continued investment in pedestrian and bike infrastructure by the Cardiff Council. Recently, there has also been marketing campaigns in the city promoting walking, cycling and an active lifestyle. There has been a growing interest from countries across the globe – especially within Europe and North America – in promoting active travel because of the environmental, health and social benefits involved (Páez and Whalen 2010; Martin et al. 2014; Ye and Titheridge 2019). Therefore, policies that make active travel attractive should be prioritized. Studies have shown that the travel satisfaction for active commuters can be affected by weather conditions, the time of the year, the presence of slopes and inclines on route, street connectivity, and the presence and quality of walking/cycling infrastructure such as pavement conditions, safety crossing dedicated walking/cycling lanes, and the aesthetic appeal of the surroundings (Stradling et al. 2007; Manaugh and El-Geneidy 2013; Willis et al. 2013). As such, improving the existing walk/cycle infrastructure within the city such as prioritising park-and-ride schemes, providing secure bicycle storage facilities in public spaces (especially around bus and train stations) and establishing laws that provide active commuters (cycle commuter most especially) with the right-of-way on roads would help make active commuting more attractive to people. Also, people might take up active commuting due to budget constraints or simply

because it is the most affordable commute solution available to them (Zhu and Fan 2018; Ye and Titheridge 2019). Therefore, policies that would help people with purchasing new bicycles or repairing their broken-down bicycles at a discount should help attract the disadvantaged. The bicycle rental initiative in Cardiff, Next-bike, has also helped in making cycling accessible to a lot more people – most especially people that would not normally opt for it. A continued improvement to this service is also advised.

Since public transport commuters reported lower travel satisfaction ratings within the study sample, there is the need to improve public transport with the aim of providing levels of satisfaction comparable with active commuters. For public transport commuters (bus and train) the way the related service and infrastructure such as cleanliness, comfort, frequency, punctuality and personnel attitudes is seen greatly affects their travel satisfaction rating (De Oña et al. 2013; Van Lierop et al. 2018). The evidence suggests that respondents within the study were dissatisfied with the punctuality and frequency of public transport in the city. Therefore, policies that make public transport an attractive option for commuters should be encouraged. Service quality issues with accessibility, punctuality, and frequency also needs to be improved. Moreover, some of these issues have resulted in wait times which has adversely affected commuters' attitude towards public transport in the study. Resources could be put into improving the available smart apps for public transportation so that real-time information on the service is available to reduce waiting time and encourage the use of public transport. Also, improvements on information systems at existing transit stations and improving in-transit services (e.g., free Wi-Fi on-board) could be explored. The fact that public transport commuters within the study experience the best and worst commute times indicates that policies that improves bus transit services (bus – worst commute time) within the area are encouraged, while also improving on the services that have made train journeys seamless. The suggested improvements to train services centres on the premise that once expectation levels have been raised, there is the danger that a decline in efficiency or consistency might reduce the overall satisfaction with the service.

Since commuting by car is the most undesirable commute mode within the study, policies that help tackle problems encountered by car commuters such as traffic congestion, travel time reliability, parking availability, annoyance with other road users, and experienced traffic safety (Novaco and Gonzalez 2009; Ettema et al. 2013) should be encouraged. Giuliano (1991) suggested that some of the most promising strategies for addressing the issues encountered by car commuters include congestion pricing, transportation demand management (parking management, alternative work hours, and ridesharing programs); expansion and diversification of public transit services, and pedestrian-oriented road designs.

Findings from the study suggests that the commute experience can be heterogenous, providing negative impacts in some cases and positive impacts in other. As such, policies that enhance the overall commute experience should be prioritized. These policies would centre around solutions to avoid commute stress by increasing the level of predictability and control people have on their car and public transport commutes. Studies have identified the impact positive utility of commute has on the travel experience. As a result, smaller measures such as more comfortable seating, unhindered view from vehicle windows, adequate travel information etc., can help public transport commuters for example experience a better commute experience and improve their travel satisfaction.

Another issue for policy intervention has to do with the car and public transport commuting findings from the study. The evidence from numerous studies consistently show that car commuters are more satisfied and/or happier than public transit users (Abou-Zeid et al. 2012; Cloutier et al. 2014; Mao et al. 2016; Lancée et al. 2017; Ye and Titheridge 2017). However, the reverse is observed with car and public transport commuters in the study. The reason for this may be traced back to the car-reliance culture within the study. The findings suggest that Cardiff residents may be overly car reliant, especially as the car is seen as a necessity. This then necessitate that policy measures that might improve car commuting within the area should focus on shaping (or changing – most precisely) people's travel behaviour. Therefore, the need to reduce the number of cars or an approach that says "the car is the problem, let's get it out of here" may be essentially what is needed. This might seem heavy-handed on initial thought, but if the goal is to make Cardiff work better for its population, improve their well-being, and at the same time enhancing overall economic, environmental and socio-cultural well-being, there is the need to embrace change. The secret to encouraging this modal change lies in making the right decisions (policy and infrastructural) to attract the envisioned change. This would fit in into the planned push for a more sustainable city in 10 years by the Cardiff Council. Some of the policy decisions to help reduce car-reliance have been discussed above. Policies that aim to promote active travel should be encouraged especially as the role of the built environment on active travel behaviour has been well established. Studies have found that a built environment featuring compact densities, mixed land uses, well-connected streets, separated and barrier-free bike lanes, and aesthetically appealing walking environments, is associated with more walking and bicycling behaviour (Susilo and Cats 2014; Friman et al. 2017a; McCarthy and Habib 2018; Mouratidis et al. 2019; Mouratidis 2020). Asides from promoting active behaviour, service quality, service frequency, attractive fares and convenient ticketing have been shown to improve public transport use (Friman et al. 2017a). Promoting full multi-modal travel and restricting car use will help focus people's attention on other travel

mode within the city. Other measures that might also help achieve this desired effect include encouraging more walkable journeys to eliminate unnecessary car journeys, encouraging carpooling among workers within the same organisation, more flexibility to work from home – especially as the pandemic has revealed that people can still get work done away from the office given the right tools, and improvements to neighbourhood transport services and facilities to mention a few. Besides, there is the evidence from this study suggesting that households with fewer cars are more likely to report higher travel satisfaction ratings. In sum, embracing a multi-modal travel approach while restricting car use should help promote changing people's travel behaviour within the study area.

Finally, the results from the mood analyses show that while people's alertness levels drop later at their workplaces or homes, they were generally positive throughout. These findings suggest how important it is for transport policies to be centred on well-being. Also, transport service providers realizing that people's travel experiences to and from work may impact their satisfaction and moods, can use this information to improve specific areas of the service provided to improve the overall travel experience for users. Furthermore, the findings suggests that people's moods are generally positive throughout their journeys, however, their concentration levels tend to drop later at their destinations, resulting in them becoming more tired compared to when their journey ended. This would have repercussions on activities conducted at the destinations (e.g., job performance at workplace, or interaction with family at home). Therefore, policy initiatives that would promote positive moods throughout the journey while reducing stressors to a large extent should be encouraged. A public transport example of initiatives to boost positive moods while reducing stressors may be to provide media screens in waiting areas or at bus stops or set up display systems on-board transport vehicles showing commuters positive messages. It is assumed that increasing people's positive moods throughout their work commute may enable them to remember that commute more positively. Also, there is the added benefit of improving their travel experience and well-being when they look back at their journeys because more time would now be spent focusing on the positive moments of their commutes as against the negative moments.

6.2.3 COVID-19 Implications to Research Findings

The Coronavirus (also known as COVID-19) outbreak started in December 2019 in Wuhan, China, and rapidly spread to many countries all over the world within its first few months (Lipsitch et al. 2020). By March 2020, the World Health Organization declared the outbreak a global pandemic, with countries such as China, Italy, Spain and the US being hit hardest during this initial period (De Vos 2020). In other to curb the spread of the COVID-19 virus,

many countries resulted to unprecedented measures restricting travel and activity participation. The UK government took numerous protective measures to slow the spread of the virus and “flatten the curve”. Some of the measures the UK government took from a transport policy perspective included: the closing down of all schools and universities, issuing a worldwide travel alert and warning against unnecessary travel abroad. Furthermore, a “stay at home” policy which included a nationwide lockdown of all non-essential activities and leisure services such as salons, restaurants, bars, clubs, gyms and churches amongst others was implemented as well as a furlough scheme that enabled many employers send their employees home and/or work from home where possible. These measures were declared social distancing measures with the aim of reducing interactions between individuals in order to slow down the spread of the virus and “flatten the curve” (Wilder-Smith and Freedman 2020). These social distancing measures significantly changed the everyday life and travel behaviour of the British population, becoming the “new normal”. The following paragraphs would examine the impacts of the COVID-19 virus outbreak on the commute mode especially in the context of findings from the study and discuss possible implications for future transport policy.

While public transport use saw a decline in use and patronage, more individualistic modes of transportation, especially the car and cycling, became very important (Abdullah et al. 2020; Beck and Hensher 2020; de Haas et al. 2020; Shakibaei et al. 2021). More people perceived public transport as negative or very negative when compared to before the start of the pandemic (de Haas et al. 2020), they also viewed public transport as less convenient and as a breeding ground for the virus (Abdullah et al. 2020; Eisenmann et al. 2021). These resulted in fewer people wanting to use this mode of transport. For those that do not have other options than using public transport, they would try to avoid crowded cabins in buses and trains by travelling during off-peak hours (Beck and Hensher 2020; De Vos 2020). Public transport users in the WELCOM study already reported lower travel satisfaction ratings which would most likely influence their future use of the service in a post-pandemic climate. In terms of car use, more people perceived the car as the most convenient form of transportation when compared to before the start of the pandemic (Eisenmann et al. 2021). People with access to cars were more inclined to drive because it protects them from other travellers and there is no fear of infection from interaction with others (Abdullah et al. 2020; De Vos 2020; Eisenmann et al. 2021). Also, there was an increase in the use of taxis and ride-hailing services especially for those without access to cars or who typically do not want to use public transport (Beck and Hensher 2020; Shakibaei et al. 2021). Car commuters in the WELCOM study have the worst commute experience of all the modes reporting lower travel satisfaction and well-being ratings and were generally the unhappiest. This is most likely to have changed over the course of the

pandemic especially since evidence have shown that the car gained the highest share of new users during the lockdown period (Abdullah et al. 2020; de Haas et al. 2020; Molloy et al. 2021). Active travel (most especially cycling) became mainstream and was positively perceived in terms of people's use and attitudes towards them during the lockdown period (Wen et al. 2020; Wang and Noland 2021). Due to a restriction in travel and activities, people took up walking and cycling as both a means of travel and for recreational purpose (De Vos 2020). Furthermore, studies show that there were more new cycle users during the lockdown period than at other times before the pandemic (Beck and Hensher 2020; Eisenmann et al. 2021; Molloy et al. 2021). Since active travel results in the experience of positive emotions, it plays a major role in improving subjective well-being (Singleton 2019,2020). Evidence from the WELCOM study points to the fact that active commuters were the most satisfied with cycling commuters being happiest. This finding would most likely remain true in light of the recent pandemic especially as more individualistic modes of transportation were positively perceived during the lockdown period (Abdullah et al. 2020; de Haas et al. 2020).

The restrictions brought about by the social distancing measures were only supposed to be temporary until the pandemic is put under control. With the development and subsequent vaccinations of people with the COVID-19 vaccine, restrictions have all but lifted and travel demand is expected to rise again. However, there is the possibility that people might still fear social contact when all social distancing rules are no longer in force, which might affect activity participation and travel (De Vos 2020). Furthermore, people might adopt these newly experienced travel perceptions and travel mode use behaviours in the short to medium term (Eisenmann et al. 2021). If this is to be the case, there is the likelihood that the UK would experience a higher number of car travel use and consequently higher greenhouse gas emissions from car journeys after the pandemic than before the advent of COVID-19 (Le Billon et al. 2021). In order to overcome the impact that the pandemic has had in particular on car use, there is the need to expand the possibilities for sustainable individual transport and develop concepts that strengthen public transport (Le Quéré et al. 2020; Eisenmann et al. 2021). The findings from the WELCOM study already leaned towards promoting a multi-modal approach to travel while restricting car use and improving the delivery of active travel infrastructure and services in the study area. It also advocated for policies that improves the delivery of public transport services all of which would help in strengthening public transport in the study area. Measures such as creating temporary cycling lanes and walk paths, restricting car use within certain local areas, and reducing wait times for pedestrians at crosswalks all help improve active travel (Shakibaei et al. 2021; Wang and Noland 2021). In addition, when developing concepts to strengthen the public transport system during the pandemic, the reduction of close unwanted contact with other travellers was the main goal. In

the UK, public transport users were required to wear face masks in public transport vehicles while trying to keep apart, there were enforcement personnel in vehicles and at stations to ensure compliance with the COVID-19 measures, and cabins of buses and trains were cleaned and disinfected daily. If the goal is to make public transport more attractive, then these measures should not be discarded in the post-pandemic world.

6.3 Limitations and Recommendations for Future Research

The novelty of the data collection method employed in the study was also its major shortcoming. Recruitment of respondents proved to be one of the biggest issues encountered during both the pilot phase and the study survey. Several measures were adopted to make the study more attractive to people including incentivising the survey process generously, reducing participant burden by limiting the daily measurements recorded, extending the survey period on multiple occasions to capture more people, switching from mail invitations to hand distributed invitations amongst others. While these measures resulted in an increased uptake by members of the public, the total number recruited did not match expectations,

As a proof-of-concept study, the novelty, complexity and multi-dimensionality of the data collection process have all been extensively discussed in the thesis. Furthermore, because of these complexities it could be presumed that participant might have had a difficult time completing the different layers of the survey to a satisfactory level. Even after recognising these complexities during the pilot survey and appropriate adjustments were made to the survey, it is understood that asking participants for several days' worth of travel information and completing related questionnaires may have been quite a lot of tasks. Ultimately, this resulted in a lower-than-expected sample size for the study. However, it should be noted that the 1,287 observations collected from the 72 participants in the survey exercise constituted a very rich dataset that was used for the data analysis.

Since the total number of respondents were few, this affected the general representativeness of the sample. It is strongly believed that this insufficient sample size issue resulted in a few analyses results being statistically insignificant. Thus, the study erred on the side of caution when reporting the findings – especially when it came to making assumptions about the population. It is recommended that future studies work with larger sample sizes representative of their population to combat this issue. It has been proposed that the major debilitating factor affecting the widespread use of smartphone applications as a travel information survey tool is the low acceptance rate (Susilo et al. 2017). Data privacy and data protection concerns especially because of the installation of an application from an unknown source may pose a

major concern for respondents. The case of Rome and Coventry in the METPEX project are examples illustrating this problem where 0 and 6 respondents respectively opted to download and use the smartphone application despite the publicity and incentives offered (Susilo et al. 2015; Susilo et al. 2017). Similarly, another study using a passive data tracking method for data collection stated how difficult it was getting a representative sample (Revilla et al. 2017). A recent study discovered that passive data tracking via smartphones or linkage to register data seem to be the least popular data collection modes for online data collection (Mulder and de Bruijne 2019). The WELCOM study employed these two approaches (passive data tracking and linkage to an online survey) in collecting data which may explain the reason it struggled with recruitment. Future studies that would want to employ an online temporal dimension in data collection would need to overcome this hurdle.

Another issue is the difficulty that surrounds real-time data collection. While real-time data collection of travel satisfaction and well-being is more precise and reduces memory bias, they may also pick up short-term variations which may have been influenced by completely random factors. For example, reporting well-being levels after performing an undesirable chore may influence that rating more negatively than say, providing a rating after having a favourite meal. Unfortunately, the study has no recommendation to help combat this random factor issue, but further research may be needed to ascertain how negligible these effects may be. Also, these issues could have affected the mood reports in the study. The study measured the spill-over effects of the respondents' commute on their lives through a record of their moods at the allotted intervals throughout the study. So, mood I was measured just before the commute, mood II measured immediately after the commute and mood III measured 90 minutes after the commute. The extent to which the commute affected the mood at these different intervals is not known. The question here is, how much of that commute experience before, during and after (actually) affected the mood? Again, could random factors unrelated to the commute have played a role in the reported moods? Could the perceived satisfaction or dissatisfaction with a commute mode before the commute influence the reported mood afterwards? These are some of the questions that future research could seek to address.

Furthermore, there is the possibility that the season (and weather) caused some variations in the reported ratings. The study was conducted between early winter and early spring in the UK and the weather conditions may have caused daily variations which might not have been present if the study was conducted another time. As such, this limitation of the study is recognised, and it is advised that future research might want to investigate the effects the seasons and weather would have on a study of this nature.

With the findings from this study advocating for a more sustainable approach to travel through the embracing of a multi-modal use of transport services, restrictions in car use, promoting active travel and investing in public transport facilities and services, one wonders the impact of a study like this on newer transport technologies like Mobility-as-a-service (MAAS). MAAS seeks to provide an integrated and an all-inclusive access to available means of transportation for a journey in order to make journey times more flexible, cost-efficient and sustainable. Future research would want to expand travel satisfaction and well-being questions to include all available transport mode within that particular area which would be effective in analysing how efficient MAAS measures could be adopted in the area.

Lastly, future research might want to consider how future research on travel satisfaction and well-being might want to consider the following; the effects of the exact activities conducted during the commute to enhance positive utility, the effects particular company have on commuters during their commute (i.e., being with spouses may cause commute experience to be rated higher than being with children), the temporal variations of travel satisfaction during peak hours and non-peak hours, and the effects of commute mode switching on travel satisfaction and well-being after changing due to continued commute dissatisfaction. All of these would pose very enlightening results to travel and well-being studies.

6.4 Conclusion

This research has achieved its initial aims and objectives and has addressed some of the gaps in the existing travel and well-being research. It has also contributed to the knowledge of understanding the links across commuting, travel satisfaction and well-being. By designing a real-time measure to capture the effects of multiple satisfying and dissatisfying trips on the commute experience, this research has been able to highlight the correlates of travel satisfaction and well-being. Research in modern societies has shown that higher levels of well-being is possible for most people and that an individual's well-being depends to a considerable degree on the choices that they make in life (Lyubomirsky 2008). One of these choices is choosing what transportation mode to use for their commuting between the home and work and vice-versa – which is an important aspect of modern living that accounts for a considerable part of daily time spent outside the home (Lancée et al. 2017). This reinforces the need for research into travel satisfaction and well-being as having this information would not only inform policy decisions for improving the commute experience, but it would go a long way to improving the well-being of the population.

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APPENDIX I – APPENDIX TO CHAPTER 2 (LITERATURE REVIEW CONTEXT)

A SUMMARY OF RELEVANT EMPIRICAL STUDIES ON TRAVEL BEHAVIOUR, COMMUTING AND WELL-BEING

Research Study	Country	Research Focus	Methodology	Analysis	Research Findings
Abou-Zeid, et al. (2012)	Switzerland	Commuting, Travel happiness and Mode switching	A survey of 30 selected individuals	A correlation analysis was used to test various commuters' satisfaction ratings with various travel modes	The results suggested that passengers who switched from private car to public transit showed the highest level of travel happiness.
Currie, et al. (2010)	Australia	Transport Disadvantage, Social Exclusion and Well-being	A survey of 535 households	The inferential analysis techniques adopted include the Correlation analysis, the Regression Analysis, and the Analysis of Variance amongst others	The results suggests that the transport disadvantaged living on urban peripheries demonstrated sustainable trade offs to balance accessibilty and mobility
Green, et al. (2014)	England	Mobility and Well-being in Older Citizens	A survey of 47 participants (aged 60 and above)	A critical analysis of the qualitative data collected during individual and group suveys	Results from the study suggested an improvement to health services and health-related goods accessibility amongst older citizens and an enhancement to their overall well-being
Best and Lanzendorf (2005)	Germany	Gender Differences in Metropolitan Car Use and Travel Patterns	A survey of 949 adults using face-to-face interviews	Regression models were used to test the associations between car use, socio-demographic variables (including gender), and commuting trips.	Women make fewer journeys for work than men. They also make more joiurneys for 'maintenance travel' such as journeys for child care and shopping. Furthermore, women are less car dependent than men.
Cao et al. (2006)	USA	Built Environment and Pedestrian Travel	A postal questionnaire survey of 1,368 households drawn through a random sample of 6,000 households from 6 suburbs.	Regression models were used to estimate the frequencies of strolling trips and pedestrian shopping within the last 30 days around the neighbourhood amongst others.	The most important factor that determines walking to a destination (say, for shopping) is the impact of residential self-selection. Furthermore, the impact of the built environment on travel behaviour depends on the purpose of the trip, as such the built environment and travel behaviour may be a function of residential location choice.
Cervero (2002)	USA	Built Environment and Mode Choice	Selected sample from 5167 households from the Household Travel Survey of 1994.	Regression Models were used to measure the influence of socio-demograhic variables, and travel costs on density, diversity and design (3 core dimensions of the built environment)	Findings suggests that the intensities and mixtures of land use significantly influence urban travel mode decisions.
Dieleman et al. (2002)	The Netherlands	Urban Form and Travel Behaviour	An interview of 70,000 households (which included individuals aged 12 and above) obtained from the Netherlands National Travel Survey (OVG)	Regression models were used to analyse the importance of each factor (personal attributes, type of residential environment, and trip purpose) on the selected travel behaviour characteristics	Findings suggested that households with higher income are more likely to own and use a car and families with kids are more likely to own and use a car. Furthermore, the purpose of the trip influences the travel distance and modal choice.
Giuliano and Narayan (2003)	USA and UK	Travel Patterns and Urban Landform	95,360 individuals aged 5 years and over from 42,033 households were sampled using telephone interviews and the Nationwide Personal Transportation Survey (NPTS) in the USA.	Various inferential statistical models were employed to test the relationship between landuse patterns, travel, and car ownership	Due to the existing landuse patterns in the USA, a higher dependence on private cars was observed.

			23,167 individuals from 9,688 households were sampled using telephone interviews and the National Transport Survey (NTS)		In the UK, a higher dependence on public transport brought about by a more compact urban morphology is observed. The differences in household income and urban form between these areas, explain the variations in number of journeys undertaken and distances travelled.
Humphreys, et al. (2013)	England	Active Commuting and Physical and Mental Well-being	989 working adults (aged 16 and above) were sampled through a postal questionnaire survey.	Regression Models were used to test associations between active commuting and physical and mental well-being	The greater the amount of time spent on active commuting, the higher the levels of physical well-being. Associations with mental well-being was inconclusive.
Hensher and King (2001)	Australia	Travel Costs (Parking Demand) and Travel Behaviour	A questionnaire survey of 416 carpark users, 100 train users, and 100 bus users	Regression models were used to estimate the relationship between travel mode and parking choices, which was then used to determine the impacts car park pricing had on car parking within the CBD.	The cost of car parking is the major determinant whether Sydney residents opted to drive into the CBD, not the availability of parking spaces. Furthermore, a 3% change in CBD parking as compared to a 97% change was observed when availability was compared to price.
Hiscock et al. (2002)	Scotland	Car Ownership and Psycho-social Benefits	This is the second part of a two part study. 3,250 postal questionnaires were sent out in the first part. This part is based on face-to-face in-depth interviews with a sample of car owners and non-car owners from the original sample in Part 1.	A critical analysis of transcribed recorded interviews using QSR NUD.IST 4 – a software package for development, support and management of qualitative data analysis projects.	The results suggests that psycho-social benefits of protection, autonomy and prestige may help to explain people's attachment to cars and also why studies have found consistently that car owners are healthier than non-car owners. Car ownership accords competence, skill, masculinity and prestige all of which are socially desirable attributes.
Mokhtarian and Salomon (2001)	USA	Travel Demand	A 14-page questionnaire survey (including socio-demoraphic and travel attitude variables) of 1,900 respondents out of 8,000 sent out	A critical analysis of descriptive statistics providing a summary results of variables focussed on (travel characteristics and personality traits) in the study	The study suggests that travel can be desired for its own sake (undirected travel), under certain circumstances. People may enjoy the sense of speed, motion, control, or aesthetic values even when undertaking mandatory or maintenance journeys. In this situation, travel is seen as constituting the activity not as a byproduct of an activity.
Naess and Jensen (2004)	Denmark	Urban Morphology and Travel Behaviour	A questionnaire survey of unnamed number of residents in 11 residential areas, augmented with 6 qualitative household interviews	A regression model was used to measure the relationship between total travel distance in a week and the travel distance between homes and city centre. The relationship between socio-demographics and travel distance between homes and city centre was also measured using this model	Evidence suggests that urban structures can influence travel behaviour even in a small town even when socio0demographics and residents' attitudes are taken into consideration. Furthermore, accessibility to key services and facilities also plays an important role
Martin, et al. (2014)	England	Active travel and Psychological Well-being	17,985 adult commuters in 18 waves of household surveys between 1991/2 – 2008/9	Regression Analysis used to investigate commute time, commute mode, effects of active commute switching on overall psychological well-being	Findings suggests significant associations between active travel and psychological well-being

Ory and Mokhtarian (2005)	USA	Willingness to Travel	A 14-page questionnaire administred to 1,358 commuting resudents in 3 suburban neighbourhoods.	Regression models were used to access how much individuals like to travel, choice of travel mode, travel distance, and travel purpose.	The results is indicative of travellers' personalities and attitudes being more important determinants of travel willingness. Study also suggests that travel can be desired and enjoyed in itself as against seeing it as a derived desire.
Roberts et al. (2011)	UK	Gender Differentials and Commuting Stress	15,077 adult commuters in 14 waves of the British Household Panel Survey (BHPS) between 1991 and 2004	Regression analysis used to investigate commute time, well-being, commute mode, job satisfaction and socio-demographic factors	Findings suggests that commuting has a detrimenral effect on the psychological health of women and not men.
Polk (2003)	Sweden	Gender Differentials and Travel Behaviour	A postal questionnaire survey of 1180 respondents selected via a random sample from adults residing in Sweden	A critical analysis of descriptive statistics to understand travel behaviour across the genders including socio-demographics. Inferential statistical models such as Chi-Square tests, t-tests, etc, was used to test the relationships beyween some travel behaviour questions across gender.	Findings suggests that men travel more distance, use the car more, and make more trips than women. Women are more open to transport sustainability measures, more environmentally concerned and are willing to reduce car use than men
Ettema et al. (2011)	Sweden	Travel Satisfaction and Subjective Well-being	A questionnaire survey administered to 155 university undergraduates	An analysis of variance (ANOVA) was used to test the means of travel statisfaction against travel mode and travel time on one hand, and life satisfaction (well-being) with travel mode and travel time on the other hand.	Findings suggests that the Satisfaction with Travel Scale (STS) is a very reliable measure and changes according to the travel conditions. Furthermore, STS, subjective well-being and mood were all affected by travel mode, travel time, accessibility to bus stops and number of daily activities
Legrain et al. (2015)	Canada	Commuting Stress and Travel Mode Choice	A large scale commuter online survey administered to 3,794 students and staffs of a public university over a 35-day period	Regression models were used to examine the relationships between subjective and objective factors, modal influence and stress to develop a general model of stress and three mode-specific (walking, driving and using public transit) models	Results suggests that commuting stress is a function of the interaction between objective stressors (time, control and comfort) and subjective stressors (feelings, desires and satisfaction). Furthermore, driving is the most stressful travel mode while public transit users experience the most stressors.
Stutzer and Frey (2008)	Germany	Commuting Stress	Data from 8 waves of data on subjective well-being from the German Socio-economic Panel Study (GSOEP) between 1985 and 2003	A regression model was used to establish the relationship between various variables such as commuting time, commuting distance, commuting mode, satisfaction with life amongst others.	The most important finding from this study suggested that people with long journeys to and from work are systematically worse off and report significantly lower subjective well-being. This result on commuting from an economist's standpoint is paradoxical.
Morris and Guerra (2015)	USA	Travel Mood and Trip Duration	A sample of 23,441 responses drawn from the American Time Use Survey (ATUS) over 3 years between 2010 and 2013	Regression models used to estimate the relationship between five emotions experienced during travel and other factors such as travel time, travel mode, trip purpose, and socio-demographic variables.	Findings suggests that overall, a weak relationship exists between travel mood and trip duration. However, a statistically significant negative relationship exists between them as a result of rising stress, fatigue and sadness on long journeys.
Simićević et al. (2016)	Serbia	Gender Differences and Travel Behaviour	An interview of 232 drivers over 5 weekdays between November and December 2011	An analysis of the socio-demographic variables (including gender) that influence travel behaviour	The results shows that women are less car dependent and more sensitive to travel costs

				using descriptive statistics. Inferential statistics using t-tests, and a linear arc elasticity equation was used to predict travel behaviour.	(parking prices), as such are more willing to replace a car journey with public transport. Furthermore, the authors opined that gender is a very important parameter in travel behaviour.
Polk (2004)	Sweden	Gender Differentials and Travel Behaviour	A postal questionnaire survey of 1180 respondents selected via a random sample from adults residing in Sweden	A regression analysis of socio-demographic and attitudinal factors that affects daily car use across gender	The study makes it very clear that gender is a significant variable and must be considered as a factor in travel behaviour research. Men and women simply have different travel patterns.
Nordbakke and Schwanen (2014)	Norway	Transport, Well-being, and Unmet Activity Needs in the Aged	A sample size of 4,723 respondents drawn through a random stratified sampling technique from a sample frame of 12,500 people (aged 67 and over)	Several measures of central tendency were used such as means, median, standard deviation etc., to explain data. Other statistical analysis include the use of Chi-Square tests and a Regression Analysis to test selected variables	Findings suggests that both objective and subjective levels of mobilities determine an individual's level of unmet needs. In other words, a greater mobility results in a higher well-being level.
Novaco, et al. (1990)	USA	Travel Impedance and Commuting Stress	A survey of 79 employees of two companies	Due to the multistaged level of sampling, different inferential analysis techniques were used such as the Chi-Square, the Regression Analysis, An Analysis of Variance amongst others	Travel impedance was categorised into two, physical and subjective. Physical impedance was associated with various illness while subjective impedance was associated with residential satisfaction, commute satisfaction, job satisfaction, moods in the office and home etc.
Novaco, et al. (1991)	USA	Travel Impedance, Commuting and the Home	A survey of 99 commuter employees of two industrial companies	Several inferential analysis techniques were used because of a multistaged sampling They include the Chi-Square, the Regression Analysis, the Analysis of Variance amongst others	The results suggested that the desire to move, home environment or residential satisfaction does not have a significant impact on the subjective perceptions of travel impedance. However the individual's mood at home is affected.
Olsson, et al. (2013)	Sweden	Commuting and Happiness	A survey of 713 work commuters	Descriptive statistics involving several measures of central tendency such as mean, median, standard deviation, etc., and a critical analysis of qualitative data	The most important finding suggests that job satisfaction and work commute satisfaction has a great impact on overall happiness and well-being
Schwanen and Dijst (2002)	The Netherland	Commuting time and Work Duration	Data from 19,957 direct home-to-work journeys from the 1998 Dutch National Travel Survey	Several measures of central tendency were adopted in data analysis. A Regression analysis was used to establish a relationship between travel-time ratio and commute time by work duration.	The findings suggests that the average Dutch worker spends 10.5% of the available time for travel and work on commuting which amounts to 28 mins per trip for an 8 hour workday.
Wener, et al. (2003)	USA	Public Mass Transit and Commuter Stress	51 respondents chosen systematically for initial testing in 1996. 29 original respondents were tested in a follow-up in 1999.	A mock-experimental, "pre-post change", field research design was used involving a questionnaire survey and a salivary cortisol test.	A reduction in the stress levels of commuters on the new transit line was observed. Furthermore, higher stress levels were related to longer commuter times.
Ziegler and Schwanen (2011)	England	Well-being, Mobility and the Aged	A survey of 128 older people	A critical analysis of the qualitative data collected during suvey	Findings indicate the presence of a strong relartionship between mobility and well-being. The loss of physical mobility although may affect older people's sense of well-being, it

	does not always necessarily impact negatively, as other forms of mobility compensate.

Source: Author

APPENDIX II – APPENDIX TO CHAPTER 2 (INVESTIGATING COMMUTING BEHAVIOUR, TRAVEL SATISFACTION AND WELL-BEING)

METHODS CATALOGUE FOR RECENT STUDIES ON COMMUTING BEHAVIOURS (i.e. COMMUTING TIME, MODE AND DISTANCE), TRAVEL SATISFACTION, SUBJECTIVE WELL-BEING, AND OVERALL WELL-BEING.				
S/N	**Author (Year)**	**Overview**	**Data**	**Analysis**
1	**Abou-Zeid (2009)**	This PhD thesis develops methods for the measurement of activity and travel well-being and models for linking well-being and behaviour. The aim is to enhance travel demand models which overemphasize the generalized cost of travel, to better capture travel benefits, and to contribute more broadly to the measurement and modeling efforts in the field of subjective well-being.	A sample of commuters was recruited via emails sent by the author to friends, colleagues, and anonymous web users. The sample included respondents from different countries with the largest proportion coming from the United States. Variables collected included socio-demographic characteristics, commute well-being, travel satisfaction, and work-related attitudinal questions.	The thesis develops and tests a modeling framework that incorporates happiness measures as additional indicators of utility in discrete choice models based on random utility theory. The framework is applied to modeling both activity and travel choices and in doing so, new well-being measurement methods are developed. Activity well-being is investigated both empirically and theoretically. The empirical analysis consists of the development of models of activity participation and well-being using data from a web-based cross-sectional survey of a sample of commuters. The theoretical analysis consists of the development of a framework and measures for the incorporation of well-being within activity-based models of travel demand. The analysis of travel well-being is done in the context of the commute to work. Using the web-based cross-sectional survey, structural equations model were developed to model the causes and correlates of commute satisfaction.
2	**Bergstad et al. (2011)**	This study aims to investigate whether satisfaction with daily travel has a positive impact on subjective well-being (SWB), either directly or indirectly through facilitating the performance of out-of-home activities. Furthermore, the study seeks to determine whether instrumental reasons for car use results in higher satisfaction with daily travel than other travel modes. Findings suggest that the effect on affective and cognitive SWB of satisfaction with daily travel is both direct and indirect via satisfaction with performance of activities. Also, car use plays a minor role for satisfaction with daily travel and its effect on SWB.	A survey of a population-based sample of 1,330 Swedish citizens between October and November in 2007, included measures of car access and use, satisfaction with daily travel, satisfaction with performance of out-of-home routine activities, affective and cognitive SWB, and socio-economic variables. In terms of specific measures for each variable, the Satisfaction with Travel Scale (STS) measures satisfaction with travel; the Swedish Core Affect Scale (SCAS) and Satisfaction with Activities Scale (SAS) measures satisfaction with activities; and the Satisfaction with Life Scale (SWLS) measures cognitive subjective well-being.	The data analyses first assess how much of the variance in satisfaction with daily travel (STS) is accounted for by car access and use. Then it assesses how much of the variance in subjective well-being (weekly mood, affective and cognitive SWB) is accounted for by STS. And finally, it assesses whether the effect of STS on subjective well-being is direct, mediated or both direct and mediated by satisfaction with the activities the respondents performed (SAS). In the regression analyses (ordinary linear squares multiple regressions) that address the questions above, several socio-demographic variables known to affect subjective well-being (from ma review of literature) are controlled for.
3	**Bhullar et al. (2013)**	This study tries to reconceptualized the role of hedonic (pleasure) and eudaimonic (engagement) functions as well-being processes and distinguished them from well-being outcomes. The results suggest that engaging in activities that capture both hedonic and eudaimonic processes may promote well-being outcomes such as life satisfaction.	The sample consisted of 370 university students recruited from Australia and India of the 507 individuals originally contacted. A multi-section questionnaire comprising of 9 well-being measures was administered	For the analysis, means, standard deviations, and internal reliability estimates (Cronbach's alphas) for all the major study variables was estimated. A combination of correlation analysis and path analysis using structural equation modelling (SEM) was employed for the 3 hypotheses being tested.
4	**Chng et al. (2016)**	The study explores the relationships between commute mode, neighbourhood public transport connectivity and subjective well-being.	The study used data on 3630 commuters in London fromwave two of Understanding Society (2010/11). - Subjective well-being was operationalized in terms of both a positive expression (life satisfaction measured by a global single-item question) and a more negative expression (mental distress measured by the General Health Questionnaire). - Commute mode was assessed using responses to the question *"How do you usually get to your place of work?"*	Multivariate linear regressions were used to investigate how commute mode and neighbourhood public transport connectivity were associated with subjective well-being for all London commuters and for public transport commuters only. The first model included only commute mode. A second model included connectivity (after adjusting for connectivity). A third (fully-adjusted) model added socio-demographic variables. And the fourth model added the negative well-being measure to the positive well-being model and vice-versa (controlled for SWB). Multivariate logistic regression was also used to explore the predictors of public transport over non-public transport commutes. First, whether London commuters residing in neighbourhoods with better connectivity were

			- Connectivity was operationalised using the London-based 'Public Transport Accessibility Level' (PTAL) dataset which measures public transport network density in small geographical areas, after accounting for walking access time, service availability and reliability - Socioeconomic information was also included in the analysis.	more likely to use public transport was investigated. Then whether using public transport in neighbourhoods with better connectivity was associated with greater well-being was investigated. All analyses were undertaken with Stata 13 software using the appropriate sampling probability weights.
5	**De Vos (2017)**	A study on the impact of short-term and long-term experiences on travel satisfaction, activity satisfaction and life satisfaction and how these three concepts correlates with each other. Findings suggest that life satisfaction has an important effect on both travel satisfaction and activity satisfaction. Moreover, travel satisfaction mainly has an indirect effect on life satisfaction, through participation in-and satisfaction with-leisure activities.	The study uses data from a 2012 Internet cross-sectional survey on travel behaviour, well-being and satisfaction of 1,213 respondents residing in the city of Ghent (Belgium). Data collected included socio-demographic variables, activity satisfaction and varaiables on leisure activity (type and activity company), travel satisfaction and other travel variables (mode, duration, and travel company), and life satisfaction.	A structural equation modelling approach was employed to analyse how the three concepts of travel satisfaction, activity satisfaction and life satisfaction are correlated to each other. In order to measure people's travel satisfaction the Satisfaction with Travel Scale (STS) waas used. For measuring activity satisfaction a similar scale to the STS was applied called the Satisfaction with Activity Scale (SAS) Life satisfaction was measured using the Satisfaction With Life Scale (SWLS)
6	**Dickerson et al. (2014)**	The study tries to expalin the relationship between commuting and subjective well-being by looking at the methodology employed. The authors argue that ordered models are more appropriate as they are theoretically preferable, straightforward to implement and lead to easily interpretable results.	This paper uses data from waves 6 to 18 (1996–2008) of the British Household Panel Survey (BHPS), conducted by the Institute for Economic and Social Research, based at the University of Essex, UK. The chosen waves were representative of data on overall life satisfaction, commuting information, and other socio-demographic information.	Using an econometric analysis on the chosen dataset, the authors compared the results from linear fixed effect models and ordered logit models with and without fixed-effects. An assessment of a range of alternative estimators for fixed-effects ordered models in the context of estimating the relationship between subjective well-being and commuting behaviour was undertaken.
7	**Disabato et al. (2016)**	The focus of this study is to test the discriminant validity between two proposed types of well-being – hedonia and eudaimonia – measured by both subjective and psychological well-being.	The data used for the study was obtained from the International Well-being Study collected between March, 2009 and March, 2013. The sample consisted of 7,617 late adolescent and adult participants aged 15 years and older Participants were compensated with a chance to win one of 15 $100 vouchers, an email summary of their score reports compared with others, and the opportunity to take one of three different well-being courses. The total assessment battery from the International Well-being Study contained 20 scales among which were the Satisfaction with Life Scale (SWLS), the Subjective Happiness Scale (SHS), the Scales of Personal Well-being (SPWB), and the Meaning of Life Questionnaire (MLQ).	Confirmatory factor analysis (CFA) model-fit indices for one-factor and two-factor models of well-being were compared to determine whether a one-factor or two-factor model of well-being best represented the data. The CFAs were conducted using a structural equation modelling approach (via the Analysis of Moment Structures AMOS software) and a latent variable analysis (via the R Package sofrtware). Discriminant validity between Hedonia and Eudaimonia was tested in two ways. First, the magnitude of the latent correlation between Hedonia and Eudaimonia was examined. Second, convergent validity coefficients were compared. Analyses were then repeated with subsamples based on the geographic world regions in order to obtain a representative sample of all regions of the world.
8	**Ettema et al. (2011)**	This study develops and tests a measure of travel-related subjective well-being (SWB), using the nine item self-report satisfaction with travel scale (STS). The focus here is on the effect of travel improvements on STS and how mood and satisfaction are influenced by STS.	In a survey of 155 undergraduates at Karlstad University, Sweden, STS, mood ratings, and ratings of SWB were collected for three hypothetical weekdays differing in travel mode, travel time, access to bus stops (collectively referred to as condition), and daily activity agenda via a survey questionnaire. Measures of STS, affective SWB and cognitive SWB are made in order to investigate the relationships between these variables. Measures of experienced mood was undertaken by using the Swedish Core Affect Scale (SCAS).	For the analysis, all the items used for measurement were summated and averaged before a test for reliability was undertaken for each using the Cronbach's alpha. The STS and mood sub scales were correlated, and tests of significance were performed by means of an overall analysis of variance (ANOVA) followed by separate t-tests, sonly significant at 0.05. A parallel five (condition) by three (agenda) mixed factorial analysis of variance with repeated measures on the last factor was performed on all measures. Furthermore, independent t-tests were also on each measure using selected conditions.

			And SWB was measured by using the Satisfaction With Life Scale (SWLS)	
9	**Friman et al. (2017a)**	This research investigates whether satisfaction with all daily travel (including work commutes, school, leisure, and shopping trips) is related to life satisfaction and emotional well-being.	The study uses a random sample of 367 participants recruited from three urban areas in Sweden (Karlstad, Göteborg, and Stockholm) varying from a small through to medium, and to a large population size. Through a questionnaire method, the participants reported retrospectively their satisfaction with all daily travel, life satisfaction, and emotional well-being. Questions on socio-demographic characteristics were also asked from the respondents.	A set of Ordinary Least Squares (OLS) multiple linear regression analyses are first performed with the dependent variables Satisfaction with Travel (STS), Emotional Well-being (EWB), and Satisfaction with Life (SWLS) and the sociodemographic variables, travel mode, urban area, and season as independent variables. Direct and indirect effects of travel satisfaction on life satisfaction and emotional well-being were analysed using the SmartPLS3.0 software. Travel satisfaction was measured with the Satisfaction with Travel Scale (STS) Emotional well-being during the last month was measured by asking participants to rate how frequently they had felt different intensities of four mood states (similar to the STS above). The Satisfaction With Life Scale (SWLS) was used to measure satisfaction with life.
10	**Friman et al. (2017b)**	This study addresses the question of how work commutes change positive versus negative and active versus passive mood experienced after the commutes.	The study adopts data from 230 time-sampled morning commutes to work, made by 146 randomly sampled people in three different Swedish cities, asking them to use their smartphones to report mood before, directly after, and later in the work place after the commute. Measures in the study included; - Traveller attributes, which included basic socio-demographics such as age, sex and location. - Mood, measured by the question *"How do you feel right now?"* made at time *T0, T1, and T2,* always before answering any other questions. - Satisfaction with Travel, measured by a shortened Satisfaction with Travel Scale (STS) which contains three dimensions. - Commute Characteristics, measured by questions on mode, duration, delays, in company, and experience on any critical incidence asked at time *T1* - Non-travel mood influences, measured by asking the question *"Has something occurred since you answered the questionnaire last time that made you feel differently?"* at a time *T2*	The mean, standard deviation, skewness, and kurtosis was employed to analyse each variable that was used in a multiple linear regression analysis. This included all the measures decribed in the previous section. Afterwards, two separate regression analyses were reported with the two measures (Valence and Activation) of mood immediately after the commute (at time *T1*) as the dependent variables. Then another two separate regression analyses was reported with the same two measures of mood obtained later at the work place (at a time *T2*) as the dependent variables. Finally, three separate regression analyses were reported with the STS measures of satisfaction with the commute as dependent variables. A fixed effects linear regression model was applied for the STS measures.
11	**Gao et al. (2016)**	This study addresses the relationship between subjective well-being and travel satisfaction will be addressed. Findings from the study suggests that travel satisfaction isn't positively correlated with subjective well-being. Furthermore, subjective well-being seems to significantly influence travel satisfaction.	To identify this relationship, data were collected in January of 2015 in Xi'an, China using a random sampling procedure. A questionnaire survey was administered to 1464 respondents within the province. The questionnaire covered socio-demographic characteristics, overall life satisfaction, satisfaction with different life domains, and questions about personality and eudaimonic well-being. All of these questions asides from the personality traits were synthesized by the authors from a combination of several questions (from a review of literature).	A structural equation model was estimated to find the relationships between domain-specific well-being, including travel satisfaction, and subjective well-being. In addition, socio-demographic variables and the personality of individuals were taken into account to investigate their effects on travel satisfaction and subjective well-being.
12	**Habib (2012)**	This study presents a joint trivariate discrete–continuous–continuous model for commuters' mode choice, work start time and work duration designed to capture correlations among random components influencing these decisions.	The study uses a data set collected in the Greater Toronto Area (GTA) in 2001 to estimate a model that predicts work schedules according to commute mode choice.	The modeling structure for the study takes the form of a trivariate discrete–continuous–continuous decision structure. Within this structure, the discrete choice component is modeled as a multinomial logit model and the continuous components are modeled as continuous accelerated failure time hazard models.

13	**Habib and Sasic (2014)**	A study on mode choice behaviour for peak period non-work trips (trips that are made during the peak period and are not linked to any other trips). Findings suggests that around 11 percent of peak period trips are pure non-work trips and auto driving is the dominant mode. Also more peak period non-work trips are made using the auto passenger mode than all transit modes combined.	The study uses data from a 2006 household travel survey collected in the Greater Toronto and Hamilton Area to investigate peak period pure non-work trip mode choice in the context of household mobility tool ownership (auto and transit pass ownership). The survey collects information on socio-demographic characteristics and one weekday's trip information from all household members above 11 years of age. Other data collected included; travel information (trip purpose and travel mode), household attributes and related attitudinal questions, and land use and demographic attributes of home zone (e.g population size, population density, total employment and employ,emt per unit area, etc.)	An econometric modelling approach was used for capturing mode preference heterogeneity. A generalized extreme value (GEV) model with scale heterogeneity was proposed for investigating the role of mobility tool ownership in peak period non-work travel mode choices. This GEV model was also used to explain the influence of household mobility tool ownership on peak period pure non-work trip mode choices in terms of explaining both preference heterogeneity and scale heterogeneity.
14	**Haider et al. (2013)**	This study explores the association between work trips and the stress experienced by workers. The relationship between workers' self-reported levels of stress and the quality of their commutes are thus explored. Findings suggest that the frequency of traffic congestion, the satisfaction with, and the duration of, the commute does impact stress levels.	The study uses data from Cycle 24 of the General Social Survey (GSS) on workers, conducted by Statistics Canada in 2010. The stress question was self-reported ranked on a scale of 1-5 from "not at all stressfull" to "extremely stressful". The commuting satisfaction question was also self-reported, ranked over a 4-point scale. The data also includes information on the mode choice, distance travelled, the duration of the commute, as well as the typical level of congestion, perceived convenience of commuting, and socio-demographic characteristics of respondents.	Multiple statistical analyses were conducted to identify the effect of commuting on stress. First, contingency table analysis was used to identify relationships between stress and a set of variables that were found to be significant from a review of literature. The joint frequency distribution was analyzed with the chi-square test statistic. Later, the level of self-reported stress on attributes of the respondent as well as the characteristics of the commute were regressed. Ordered probit models were estimated, which can be represented as follows: $y*=\boldsymbol{x}'\beta+\epsilon$, (1) 138 where, $y*$ is the level of stress, an exact but unobserved dependent variable; $\boldsymbol{x}$ is the vector of independent variables; and, β is the vector of regression coefficients. 143 To compute for the latent variable when $y*$ cannot be observed, the observed categories are: y={1 if $y*$=0; 2 if 0<$y*$≤μ_1; 3 if μ_1<$y*$ Using the model for the latent variable y along with the threshold, μ1, one can determine the cumulative probability distribution Pr($y \leq j$) = Pr ($\epsilon \leq \mu j - \boldsymbol{x}'\beta$), where the errors, ϵ, are independently distributed according to the standard normal distribution.
15	**He and Zhao (2016)**	The study identifies the determinants of long-duration commuters' perceptions towards commuting time.	A total of 753 valid questionnaire samples were collected from 795 commuters in the city of Kunming, China. Dataset used included respondents' socio-demographic information and commuting time.	Logistic regression models were used to identify the determinants of long-duration commuting trips based on the samples collected. The variables used in these models were from the dataset information mentioned in the previous section.
16	**Hennessy (2008)**	This study highlights the interactive nature of traffic and workplace environments, in that negative experiences in the traffic environment may spill over for some individuals to influence other non-driving events.	Participants in the study consisted of 114 students from Buffalo State College who were employed off campus and commuted to work via personal vehicle. Participants completed; - Socio-demographic questions - Overall trait aggresiveness questions measured by the Aggression Questionnaire (AQ). - A self-report on their exposure to daily hassles measured by the Survey of Recent Life Experiences (SRLE). - The state driver stress questionnaire which is a derivative of the Driving Behaviour Inventory-General (DBI-Gen). - A short form of the Drtiving Anger Scale (DAS) - And a revised version of the Workplace Aggression Scale (WPA).	A multivariate analysis of variance (MANOVA) conducted over the entire questionnaire lot found an overall gender effect to be very evident. Individual questionnaires were subjected to a between-subject tests for gender, intercorrelations, means, and alpha reliabilities. Separate hierarchical entry multiple regressions were conducted for expressed hostility, obstructionism, and overt aggression in order to examine the influences of state driver stress on workplace aggression.

17	**Ignacio Gimenez-Nadal et al. (2018)**	This study analyzes the commuting behavior of workers in the United States, with a focus on the differences between employees and the self-employed. The results suggest that there is a complex relationship between urban form and the commuting behaviour of workers.	The American Time Use Survey (ATUS) for the years 2003–2014. The ATUS provides information on individual time use, based on diary questionnaires in which individuals report their activities throughout the 24 h of the (previous) day. Of particular interests to the study were information on commuting mode and time, socio-demographics such as age, iincome, location, population size, and job characteristics such as occupation, type of employment etc.	Using Ordinary Least Squares (OLS) regression estimates on the time devoted to commuting, an econometric model was determined. For a given individual "i"; $Ci = \alpha + \beta * Employeei + \gamma * Xi + \varepsilon i$ Where *Ci* represents the daily min individual"i" devotes to commuting, *Employeei* be a dummy variable to indicate whether respondent "i" is an employee (1) or not (0), *Xi* is a vector of socio-demographic and job characteristics, and εi is a random variable that represent unmeasured factors.
18	**Kolodinsky et al. (2013)**	This study estimated how the availability of built amenities, natural amenities, weather and attitudes toward travel explain actual and unserved travel demand and subsequently quality of life.	A 2009 survey of residents of Vermont, Maine, and New Hampshire was used in the study. The survey was conducted using computer-aided telephone interviewing (CATI) and an online data-collection tool. Data collected from the study included; - Socio-demographic information i.e, age,m sex, income, education, etc. - Natural and built environment information, measured by rating the perceived availability of eighteen community amenities on a scale from zero to ten. This is used to measure the Quality of Life (QOL). - Travel and weather attitudinal questions, rated on a five-point Likert scale.	Three structural equation modeling (SEM) approach were used due to the complex nature of modelling quality of life and its influencing variables. SEM 1 used a standard binary logistic model with unserved travel demand as the dependent variable to predict the probability that a respondent had any form of unserved demand. SEM 2 used a two-step, truncated regression model with total number of trips as the dependent variable to predict the probability of a respondent making at least 1 trip. SEM 3 used linear Ordinary Least Squares regression techniques with QOL as the dependent variable. Included in this regression were the previously included independent variables: community amenities, attitudinal statements regarding travel, characteristics, and measures of the weather. All analyses were conducted with the Statistical Program for Social Sciences (SPSS), version 18.0 and LIMDEP Econometrics Software, version 8.0.
19	**Krueger and Schkade (2008)**	This study explores the test–retest reliability of a standard self-reported life satisfaction measure and of affect measures collected from a diary method.	The sample consisted of 229 women who were interviewed on two Thursdays, two weeks apart, in Spring 2005. Respondents were paid $50 upon completing the first questionnaire and an additional $100 upon completing the second one for a total of $150. The test–retest reliability of two types of measures of subjective well-being were analysed: a standard life satisfaction question and affective experience measures derived from the Day Reconstruction Method. All of these are available on request from the authors.	Correlation anlysis was the main analytical tool used for this study. The correlation of net affect (i.e., duration weighted positive feelings less negative feelings) measured two weeks apart is .64, which is slightly higher than the correlation of life satisfaction (r=.59). Life satisfaction is found to correlate much more strongly with income than does net affect. Components of affect that are more person-specific are found to have a higher test–retest reliability than components of affect that are more specific to the particular situation.
20	**Legrain et al. (2015)**	This study compares commuter stress across three modes of transportation (walking, driving, and using public transit). It also investigates the specific factors that contribute to stress using these modes.	The data used for this study is compiled from a large-scale online commuter survey administered to 3,794 students and staffs at McGill University in Montreal, Canada over a 35-day period. The questionnaire included information on; - Commuting characteristics - Travel satisfaction - Socio-demographic characteristics	This study uses a series of ordered logit regressions to examine the relationship between subjective and objective factors, modal influence, and stress. For all models, reported stress is the dependent variable. For independent variables, relevant variables based on a review of literature concerning stress and subjective well-being were used. Control variables were also included to accommodate for demographic differences and residential location choices. Other relevant variables were also included to capture both objective stressors and subjective experiences related to these stressors.
21	**Lorenz (2018)**	This study analyses the relation between commuting and subjective well-being by considering several cognitive (e.g., satisfaction with family life, leisure, income, work, health) and affective (e.g., happiness, anger, worry, sadness) components of subjective well-being.	The study uses data from working adults aged 18 – 65 from the German Socio-Economic Panel survey for the period between 2007 and 2013. The dependent variables includes affective and cognative evalaution questions from the surbey rated on a 11-point scale (0-10).	Because of the longitudinal nature of the data used, fixed-effects models were estimated. The empirical model employed is summarised as: $SWBit = \alpha i + \beta CDit + \gamma CD2it + \lambda Xit + \varepsilon it$ where *SWBit* denotes the individual's well-being, αi denotes time-invariant idiosyncratic effects, β is the coefficient of commuting distance *(CD)*, and γ is the coefficient of its squared term *(CD2)*. To

			Explanatory variables used in the study included commuteing time and time use (for different activities. Socio-demographic variables were used as control variables.	evaluate the effect of commuting distance on subjective well-being measures, one needs to perform a test for joint significance. The vector *X* includes all the control variables.
22	**Martin et al. (2014)**	The aim of this study is to explore the relationship between active travel and psychological well-being. The result suggests that significant associations were observed between overall psychological well-being and active travel, public transport (when compared to car travel) and journey time (walking and driving).	This study used data on 17,985 adult commuters in eighteen waves of the British Household Panel Survey (1991/2–2008/9). Psychological well-being was measured using a 36-point Likert scale. Commute information including mode and time was also considered.	Fixed effects regression models were used to investigate how (i.) travel mode choice, (ii.) commuting time, and (iii.) switching to active travel impacted on overall psychological well-being and how (iv.) travel mode choice impacted on specific psychological symptoms included in the General Health Questionnaire.
23	**Mattisson and Cromley (2015)**	This study investigates the spatial heterogeneity in levels of stress over time reported by workers with long car commutes, given the dominance of that mode.	The study population was drawn from a public health survey conducted in Southern Sweden in the year 2000 with follow-up in 2005 and 2010. Each of the 997 individuals included in the study was between 18 – 65 years old at baseline worked 15 – 60 hours per week, commuted 30 – 60 minutes by car, reported a valid stress level (self-reported via a cross-sectional survey), and had residential location coordinates in the county in one or more years of the panel.	For the analysis, geographically weighted proportions were calculated for each commuter in the study population for each time period using a fixed bandwidth of 20 km and Gaussian quadrature weights to identify areas with high proportions of car commuters reporting stress. Furthermore, for selected areas with high proportions of commuters reporting stress, local proportions of stress in car commuters are compared to proportions for the county as a whole.
24	**McMahan and Estes (2011a)**	The prediction that eudaimonic dimensions of individual conceptions of well-being are more robustly associated with self-reported well-being than hedonic dimensions was investigated in this study. Findings from the study generally suggest that conceptualizing well-being in eudaimonic terms may be relatively more important for positive psychological functioning especially as only eudaimonic terms significantly predicted well-being.	115 students were sampled from the undergraduate population of a medium sized public university. All participants completed a multi-section questionnaire distributed using an online testing system. Included in the questionnaire was a brief demographics survey, a self-report measure of conceptions of well-being, and several self-report measures of experienced well-being. Conceptions of well-being were measured using the Beliefs about Well-being Scale (BWBS). The Satisfaction with Life Scale (SWLS) and the Intensity and Time Affect Sacle (ITAS) was used to measure subjective well-being.	Correlational analyses indicated that both hedonic and eudaimonic dimensions were associated with well-being, however, stronger and more numerous associations were found between the eudaimonic dimension and well-being, relative to those found between the hedonic dimension and well-being. Several hierarchical regression analyses were then conducted to examine whether the hedonistic and the eudaimonic dimensions of the BWBS predicted unique variance in each measure of well-being.
25	**Mokhtarian et al. (2014)**	This study analyzes the self-reported (mental and/or physical) fatigue associated with daily travel, and its (un)pleasantness.	The study used data from the 2007–2008 French National Travel Survey (FNTS). Variables used included socioeconomic variables, trip indicators i.e trip length, distance, purpose, activities conducted during the trip, and variables that tests fatigue and pleasantness in the individual.	The study presents a bivariate probit model of the mental and physical fatigue associated with the trip, and binary logit models of whether the trip was pleasant (yes/no) or unpleasant (yes/no). These models are types of structural equations modelling (SEM) approach.
26	**Montini et al. (2015)**	This study provides further insight into the usefulness of smartphones and dedicated GPS devices for collecting current travel survey data.	GPS and accelerometer time series for 33 European research project PEACOX study were tracked simultaneously with smartphones and dedicated devices for 8 weeks. Meaningful travel diaries are then extracted from both data sources. The dedicated GPS was a MobiTest GSL device. For smartphone participants position data was collected in the background by the PEACOX app via their own devices. Dedicated programming of the app ensured that the logging process was not stopped by the Android Task management, and that all available location information sources (GPS and WiFi network) were used for acquiring position information.	A screening questionnaire collected the following predefined criteria: age 18 or older, living and working, or studying, in the test area, a smartphone (running Android OS 4.0 or newer) for at least three months, including an associated data plan with a minimum of 500 MB per month and, during the eight weeks of trial, no planned absence for more than one week (e.g. holiday outside of the study regions). To process GPS and accelerometer data the software package POSDAP (2012) is used. The three most relevant steps when creating travel diaries are: - Cleaning of raw data: GPS points are filtered when too few satellites are accessible or accuracy measures are bad. - Identification of activities and trips: mainly based on point clouds, signal gaps and changes in the accelerometer signal if mode is changed to, or from, walk. - Identification of transport mode and activity type: done using a random forest classifier.

27	**Morris and Guerra (2015a)**	This study examines the relationship between travel stress and travel duration. It seeks to answer the question, are longer trips more strenuous or unpleasant than shorter ones?	The data used for the study is drawn from the American Time Use Survey (ATUS) conducted by the Bureau of Labor Statistics and the Census Bureau over a 3 year period between 2010 and 2013. The ATUS well-being module queried roughly 13,000 individuals about the extent to which they felt happiness, pain, sadness, stress, and fatigue during three randomly selected daily activities (travel activity in this study). Over 22,000 instances of individuals traveling are observed, including their trip duration, mode, purpose, socio-demographics and geographic information.	The study uses Ordinary Least Squares (OLS) regressions via structural equation modelling (SEM) to generate the model below; $\ln E = \beta_1 \ln T + \beta_2 M + \beta_3 P + \beta_4 D + \beta_5 G + \varepsilon$ where ln indicates that the natural log of a variable has been taken, E = intensity of emotion, T = travel duration, M = a set of dummies for travel mode, P = a set of dummies for trip purpose, D = a vector of demographic controls, and G = a vector of geographic controls. The dependent variables, emotions during travel (E), include the five emotions observed by the ATUS, which are examined in separate regressions including a single composite variable drawn from the five emotions, referred as ‘‘total affect’’ or ‘‘mood.’’ These emotions can all be reasonably thought of as manifestations of a latent, overall mood variable. A correlation analysis and a confirmatory factor analysis (CFA) were performed to understand the relationship between the five emotions. This allowed the resarchers to meaningfully extract a composite (a single latent variable called mood or affect) from the lot. The affect scores and individual emotion scores are also transformed to produce a normal distribution by reflecting (subtracting the score from range of observations), then logged (taking the natural log), and finally multiplied by negative one. This is done because the distrivution was skewed to the left (as people tend to genarlly report higher scores). However, if the variable exhibit the opposite skew (usually oberved with negative emotions), the natural log is taken but the variable is not reflected, though one is added to the scores to avoid taking the log of zero. Hence a more positive score for any individual emotion reflects a greater intensity of this emotion. The travel variables are also transformed to correct for positive skew.
28	**Moulin et al. (2017)**	This study aims to assess the correlates and predictors of high levels of well-being using Corey Keyes’ model (in Keyes 2002, 2007) of mental health.	A four-year longitudinal population-based mental health and well-being study targeting adults aged 15–65 years was administered in Montreal, Canada. At baseline, 1828 participated in wave 1, and 1303 in wave 2. - Well-being was measured with the Mental Health Continuum–Short Form (MHC–SF). This consists of 14 items measuring emotional well-being, social well-being and psychological well-being. - Sociodemographic and economic data were collected using the Canadian Community Health Survey questionnaire (CCHS 1.2). - Psychological distress was measured using the K-10 scale used in the World Mental Health Survey (WMH2000) and the CCHS 1.2. - Stress and stress management strategies were evaluated using several items drawn from three scales including the CSI (Coping Strategies Indicator), the WOC-R (Ways of Coping-Revised), and COPE - Components of social support were measured using the Social Provisions Scale (SPS) - The sense of belonging to a community was measured using the eight-item Sense of Community Index - Physical aspects of the neighborhood were measured using the Neighborhood Physical Conditions Scale. - Spirituality variables were identified from the CCHS 1.2 questionnaire.	For the analysis, descriptive statistics, including proportions, means, and standard deviations (*SD*), were used to characterize the study population at each wave of data collection. To identify the correlates of mental health well-being, logistic regression was used to model well-being at Wave 2. Bivariate and multivariate analyses were carried out. In bivariate analysis, a single logistic regression was used to assess variables associated with well-being, with the alpha value set at $p < 0.10$. To identify predictors of excellent well-being, multiple logistic regression was used to analyse the difference in well-being scores from time *T1* to time *T2*. Mixed model regression was used to analyse repeated measures of well-being across waves of data collection. For all multivariable logistic regression analyses, 2-tailed tests of statistical significance were performed, with alpha set at 0.05, to differentiate associations between well-being and predictor variables while adjusting for all other independent variables in the model.

			- A geographic information system (GIS) was used to characterize and measure neighbourhood environmental contexts.	
29	**Olsson et al. (2013)**	This study investigates the assertion that happiness is being able to make the routines of everyday life work. This is illustrated by showing that satisfaction with the work commutes contributes to the individual's overall happiness.	The participants were 713 work commuters age ranging from 20 to 65, living in the three largest urban areas of Sweden (Stockholm, Goteborg, and Malmo). The participants answered a mail questionnaire that had three consecutive modules consisting of questions about the work commute, overall happiness, and sociodemographics. Satisfaction with Travel Survey (STS) was used to assess satisfaction with the commute to and from work. Satisfaction with Life Scale (SWLS) was used to assess overall happiness.	A composite measure of satisfaction with the work commute was formed by averaging across all nine STS scales. Means and standard deviations were conducted on the composite measure of satisfaction. Aftwerwards, correlation analysis were conducted between these and the the primary travel mode for both commutes to and from work. Multiple linear regression analysis were used to determine the significance between overall happiness, commute time and commute modes, with SWLS and affect balance as dependent variables, separately for the commutes to work and from work.
30	**Roberts et al. (2011)**	The study explores the effects of commuting time on the psychological health of men and women.	Using data from 15,077 adult commuters in 14 waves of the British Household Panel Survey (BHPS) between 1991 and 2004. The dataset included variables known to determine psychological health, as well as factors which may provide compensation for commuting such as income, job satisfaction and housing quality along with some selected socio-demographic factors.	A fixed effects framework was used to estimate the effect of time spent commuting on psychological health, after controlling for other factors expected to determine well-being such as income, job satisfaction and housing quality. A variety of models were estimated, and a number of robustness checks were undertaken to satisfy the reliability of results such as excluding variables that may be endogenous, estimating the models on various sub-samples and dealing with possible measurement error in reported commuted times by using a dichotomous indicator for high/low commuting time.
31	**Santhosh (2015)**	The objective of this study is to measure the impact of workplace commuting on organisational citizenship behaviour (OCB) of employees.	A total of 386 questionnaires from employees working in public and private sector organizations in the southern part of India was used for this study. Information included in thios questionnaire were socio-demographic characteristics, commuting characteristics and organisational citizenship behaviour measured by a four dimensional scale developed by Moorman and Blakely in the year 1995.	Basic descriptive statistics were used to expalin the socio-demographic and commuting characteristics information from the survey. The four dimensions of organisational citizenship behaviour was measured and correlated with each other. Furthermore, some selected socio-demographic characteristics and commuting characteristics were correlated with each of the four dimensions of organisational citizenship behaviour.
32	**Simićević et al. (2016)**	This study presents pioneering research on gender differences in travel behaviour in southeastern Europe. Additionally, it examines the influence of parking demand management measures on their behaviour, in terms of the willingness of men and women to reduce car use and to adopt a more sustainable behaviour.	An interview of 232 drivers over 5 weekdays between November and December 2011 The study collected data on|: - socio-economic characteristics of the driver including gender, income (here conveyed as engine size and age of the car), and car dependency. - parking/trip characteristics including trip origin and destination, car occupancy, user category (visitor or parking permit holder), whether employer pays for the parking, parking purpose and frequency, rank of parking quality parameters, and parking search time. - visitor sensitivity to parking charge determined by a question about an increase to existing on and/or off street parking charges.	For the data analysis, descriptive statistics were employed to analyse the socio-demographic variables (including gender) that influence travel behaviour. Inferential statistics using t-tests, and a linear arc elasticity equation was used to predict travel behaviour in terms of willingness to adopt a more sustainable travel behaviour; $$\eta = \frac{(\Delta Q / ((Q_1 + Q_2) / 2))}{(\Delta P / ((P_1 + P_2) / 2))}$$ where η is the elasticity coefficient, P_1 the first parking price, P_2 the second (hypothetical) parking price, Q_1 he parking demand at price P_1, and Q_2 the (predicted) parking demand at price P_2.
33	**Singleton and Clifton (2017)**	This study describes how hedonic and eudaimonic travel subjective well-being can be measured.	The data used was obtained from a sample of 700 commuters in the fall of 2016, in Portland, Oregon, USA. An online questionnaire survey was employed. The data collected included information on: - socio-demographic characteristics	Four inferential statistics types were employed to analyse the data from this study. Exploratory factor analysis (EFA), confirmatory factor analysis (CFA), structural equation modelling (SEM), and integrated choice and latent variable modelling (ICLV). The experienced travel subjective well-being of hedonia and eudaimonia were both analysed using the confirmatory factor analysis.

			- travel characteristics - work characteristics - experienced subjective well-being during travel	A correlation analysis was used to describe the relationships between the forms of travel subjective well-being being tested.
34	**Solvoll and Hanssen (2017)**	The study examines factors that are most important for the users' overall satisfaction with specialised transport services for the disabled (STS) in Norway focusing especially on gender differences.	The data is collected from Specialised Transport Services (STS) users in Buskerud, a county west of the capital Oslo with an average population density of 20 inhabitants per km^2. A total of 210 questionnaires were used in the analysis after an initial 800 was distributed to STS users in the county. Asides from basic socio-demographic and travel information, the respondents were asked two questions about their overall satisfaction with specialised trasnport services	From the two satisfaction with STS questions, an un-weighted index score was calculated and was used as an independent variable for the regression analysis with seven dependent variables (e.g safety, punctuality, price, comfort, etc.) widely accepted to influence demand and quality of transport services from a review of literature. To analyse how satisfaction with transport quality elements influences users' overall satisfaction with the STS (OS), the following model was employed: $OSi = \alpha i + \beta ix^1 + \beta ix^2 \ldots + \varepsilon$ Where αi is a fixed term, $\beta ix^1 + \beta ix^2$ are the seven dependent variables, and ε is a random error term with constant variance and an expected value of zero.
35	**Stutzer and Frey (2008)**	Commuting Stress	Data from 8 waves of data on subjective well-being from the German Socio-economic Panel Study (GSOEP) between 1985 and 2003. People in the survey were asked a wide range of questions with regards to their socio-economic status and their demographic characteristics. Moreover, they reported their actual commuting time (determined by the question, “how long does it normally take you to go all the way from your home to your place of work using the most direct route (one way only)?”) and their subjective well-being (based on the question, “how satisfied are you with your life, all things considered?”)	Descriptive statistics for the dependent variable life satisfaction, as well as all the covariates used in the empirical analysis (such as age, commuting time, commuting distance, etc) was first undertaken. To predict the correlation between commuting and reported satisfaction with life, a regression model was estimated as follows; $ui = \alpha + \beta Di + \varepsilon i$. where β measures the total change in utility due to a change in commuting time D. Multiple regression models were used to predict the relationship between different socio-demographic variables, commuting (mode, time and distance) and satisfaction with life.
36	**Susilo et al. (2017)**	This study describes the lessons learned from designing, deploying and analysing the results from different travel satisfaction survey tools which measures door-to-door travel satisfaction. This study is part of METPEX FP7 EU project which aims to develop a Pan-European standardised measurement tool to measure passenger experience across whole journeys, whilst taking into account wider human socio-economic, cultural, geographic and environmental factors.	The data collection was carried out in 8 European cities and 5 Fédération Internationale de l'Automobile (FIA) motorists networks. 5,275 valid responses were gathered from the survey. In order to create a single standardised passenger satisfaction survey (PSS) that accommodates different conditions within the EU countries, the measurement survey needs to be adapted into 5 different survey methods: paper-and-pencil; on-line questionnaire; real-time questionnaire embedded in a route navigation (SbNavi) app for IOS and Android; real-time questionnaire embedded in a dedicated Android game app; and a focus group discussion. First, several rounds of Multi Criteria Analysis among experts and stakeholders were carried out to set weights to the context specific indicators identified from initial review. A ranking model to detrmine what indicators to include or exclude. Based on this, the selected indicators were distributed into 5 sections; - Individual attributes (i.e. socio-demographic, mobility behaviour) - Attitudes (i.e. travel preferences, mobility-related opinions) - Contextual variables (i.e. temporal, weather conditions, trip purpose, subjective well-being indices) - Specific user groups and travel modes specific questionnaires	Descriptive analysis was employed to describe the variables across the different survey tools employed. Correlation analyses were used to describe the relationships between overall journey satisfaction with the satisfaction on different trip legs, subjective well-being spectrums, individual’s socio-demographic, and trip characteristics, by different survey methods. Finally, an ordered logit model was employed to explore how individuals who used different survey tools reported different levels of satisfaction.

			- Travel experience factors (e.g. availability, travel time components, information provision, reliability, way-finding, comfort, appeal, safety and security, customer care, price, connectivity, etc.)	
37	**Sweet and Kanaroglou (2016)**	This research explores the links between travel, activity participation, and subjective well-being with particular interests on gender differences.	This study employs data from the 2010 General Social Survey (GSS) of Time Use in Canada, conducted nationally by Statistics Canada every five years. The datasetsemployed included questions of socio-demographic characteristics of respondents, their travel information,activity participation time use information and information on subjective well-being.	In this study, structural equation models were employed to identify links between daily travel times, time use, and subjective well-being (SWB), the extent to which the overall quality of life is positively assessed. First daily travel time (natural-logged) is modelled as a function of socio-demographic characteristics and regional fixed effects. Next, a time use incident model is estimated as a function of socio-demographic characteristics, regional fixed effects, and daily travel using an ordered logistic regression model with simplified categories.
38	**Weinberg et al. (2016)**	This study extends upon a previous study on the effects of item-order in measures of job satisfaction, and applies similar principles to the measurement of life satisfaction (or subjective well-being) by exploring item-order effects within the Personal Well-being Index (PWI).	The total sample comprised 653 Australian participants, majority of which were females aged between 18 and 84 years. Questions on their socio-demographic characteristics and subjective well-being. Subjective well-being was captured by a seven-item Personal Well-being Index (PWI), and a single-item General Life Satisfaction (GLS). All participants completed an online questionnaire. Questionnaires were separated into two versions (conditions). A total of 337 participants completed the general-specific questionnaire, and 316 completed the specific-general version.	All analyses were done using IBM SPSS Version 22. After a thorough data cleaning exercise, the raw scores from the PWI were converted to a 0 – 100-point scale for comparison purposes and simple interpretation and the seven domain scores summed and averaged to give a total PWI score. For the purposes of preliminary exploration, bivariate correlations between each item for both PWI and GLS were calculated. Afterwards, the means and standard deviations for each of the PWI items, the GLS, and the total PWI score for each condition are computed. The values are compared and evaluated for significance using a series of independent t tests, and the effect size is given as Cohen's *d.* To explore the relative contributions of the PWI items to GLS, separate multiple regressions were conducted for each condition.
39	**Westman et al. (2013)**	This study aims to evaluate the variation of children's affective experience of every-day travel depending on travel mode and destination of travel. More specifically, it seeks to understand what are children's reported valence (unpleasantness–pleasantness) and activation (deactivation–activation) while travelling to different destinations and how this experience affect or how they perceive activities at the destination (spill-over effects).	206 children (101 girls) in grade 4 in public schools in the municipality of Staffanstorp, southern Sweden recorded their travels in a diary throughout a school week. The data collected included reports of travel mode, experience of every-day travel (measured via a simplified version of the satisfaction with travel scale), activities on arrival, and the experiences of activities (measured by a simplified version of the Swedish Core Affect Scale). The affect and experience measures were represented with pictorial faces extensively piloted.	Analyses of Variance (ANOVA) were used to report inferential statistics in this study. For the experiences of every-day travel, two separate one-way analysis of variance was performed with destination (home, other persons' home, school, leisure activities, entertainment/private) as independent variable and degree of valence during travel as dependent variable in the first, and degree of activation during travel as dependent variable in the second. For the experiences of the journey to school, two one-way ANOVA was performed with travel mode (cycle, car, walking) as independent variable and activation during travel as dependent variable in the first, and activation on destination as dependent variable in the second. Also, a two-way ANOVA was performed with mode and gender as independent variables and activation during travel to school as dependent variable was performed to determine gender differences in the experience of the journey to school. Further analyses was performed with the aim to analyze if there were any spill-over effects of travel mode on affective experiences during the school day. A two-way analysis of variance with mode and gender as independent variables and activation during the school day as dependent variable was carried out. A Bonferroni post hoc criterion for significance analyses was carried out to ascertain significance. A similar analysis was performed on valence during the school day.
40	**Wheatley (2014)**	This study contributes to the understanding of the interaction between travel-to-work, time-use, and subjective well-being among full-time men and women in dual career households.	Data is extracted from an empirical investigation of the British Household Panel Survey (1993–2009) for full-time working employees aged 16 - 65. The dataset included variables on satisfaction with working hours, job, amount of leisure time, and use of leisure time. Others include travel-to-work, time-use, and socio-demographic variables	Following initial descriptive analysis, ordered probit regression analysis is performed as this provides the most robust method of analysis using discrete dependent variables. The dependent variables comprise of reported levels of satisfaction with working hours, job, amount of leisure time, and use of leisure time. These are regressed against relevant travel-to-work, time-use, demographic, and occupation variables (using UK Standard Occupational Classification Major Groups). To account for potential time-varying effects in the panel data, time-use variables are considered in three separate time periods aligning with periods when time-use policies were implemented in the UK.

				Finally, the analysis includes a series of interaction variables used to test the relative combined impact of travel-to-work routines and the presence of dependent children.
41	**Wheatley and Bickerton (2016)**	This study contributes to the understanding of the complex patterns of travel-to-work and travel for-work which increasingly characterise highly skilled employment	Using the data from a 2015 UK East and West Midlands study comprising of an online survey and follow-up interviews exploring patterns of travel-to-work and travel-for-work among highly skilled workers. The dataset focussed on travel patterns, subjective well-being impacts of travel, and socio-demographics.	Basic descriptive statistics were used to summarise various information from the study. Correlation analyses were employed to explore subjective well-being impacts of travel and travel patterns, focussing on emerging themes. Finally, a thematic coding method was used to analyse the interviews.
42	**Zhu et al. (2017)**	This study investigates the relationship between commuting time and subjective well-being (SWB) in both rural and urban areas of China.	This study used 13,261 individual, 124 city, and 401 neighbourhood samples from the 2014 China Labour-Force Dynamics Survey (CLDS 2014). The CLDS 2014 questionnaires covered individual socioeconomic status, commuting situation, working conditions, and other demographic information, all of which were used in the analysis.	Due to the hierarchical structure of the CLDS 2014 data, three-level mixed-effects ordered probit regressions were performed to investigate the association between commuting and subjective well-being (SWB). In the regression model, the dependent variable was SWB. The independent variables were daily commute time (continuous variable), public transport mode, and walking/bicycling.

Source: Author

APPENDIX III – APPENDIX TO CHAPTER 3 – (SMARTPHONE APPS FOR TRAVEL SURVEY)

A SUMMARY OF THE RELEVANT AVAILABLE SMARTPHONE APPLICATIONS FOR TRAVEL SURVEY DATA COLLECTION													
S/N	**Name**	**Developer**	**Licence and Price**	**Overview**	**How It Works**								**Other Features**
					Operating System	**Sensors Used**	**Automatically Detecting Start/Stop**	**Automatically Detecting Travel**	**Detecting Travel Split Legs**	**Detecting Travel Mode**	**Detecting Travel Purpose**	**Detecting Travel Destination**	
1	SmartMo	EasyMobiz (easymobiz.com)	-Proprietary software -price N/A from app store	-A mobile travel survey tool developed by an Austrian mobile application development agency. -Used in the SmartMo project in Austria -Authors of the study were Martin Berger and Mario Platzer (2015)	Android and iOS	GPS, GSM, WiFi	No	Yes	Yes	No	No	No	-App is intuitive and learns from the user. -App does not contain a sampling option so links to questions must be included -App can be customised and gamification elements (points collection for distance walked, calories burnt etc.) can be added. -App contains a travel recall function which allows users to modify the automatically generated travel details if incorrect.
2	SbNavi	Sboing (sboing.net)	-Proprietary software -Price from free (community version) to $10 (platinum version)	-A satellite navigation mobile application developed by a Greek innovative high-tech SME in the field of ICT -Used in the METPEX project in 8 European Cities.	Android and iOS	GPS	No	Yes	No	No	No	No	-Real-time questionnaire embedded into the app by the researchers for tracking travel satisfaction at various intervals. -Uses custom maps based on free and OpenStreetMap i.e, it collects data from all users to improve itself. -Able to better provide times estimates depending on the type of vehicle, weather, road conditions etc., based on this feature.
3	Nemo-Phone	N/A	N/A	-A smartphone-based travel data collection tool that distinguishes between 8 different travel mode categories. -Used in the NEMO-PHONE project in Vienna, Austria	Android	GPS, GSM, WiFi, Accelerometer, Magnetometer	No	Yes	Yes	Yes	No	No	-Can detect 8 travel mode categories (walk, cycle, motorbike, car, bus, tram, metro, train) -Using embedded sensors, it can map location and speed information without a GPS lock.

				-Authors of the study were Philippe Nitsche								
4	BetterPoints	BetterPoints (betterpoints.org)	-Proprietary software	- The app is a rewards system which enables users to collect points for their active travel activities. -These points are later redeemed for real-world vouchers and gift cards to retail and groceries stores.	Android and iOS	GPS, GSM, WiFi, Accelerometer, Magnetometer, and other embedded sensors	Yes	Yes	Yes	Yes	No	Yes	-App is intuitive and can detect a wider range of activities. - At the end of each journey, the distance travelled, duration of travel, calories burnt, carbon footprint and travel time are presented to the user. An origin-destination map is also shown at the end of the journey. - App does not have survey questions embedded but as it customisable, this can be added to the design.
5	rMove	RSG Inc (rmove.rsginc.com)	-Proprietary software. -Free in the App Store	-A smartphone app designed to collect household travel information as well as daily tasks information, social network information, energy and residential choices to mention a few. -Authors of the study were Chiara Calastri et al (2017)	Android and iOS	GPS, GSM, WiFi, Accelerometer, Magnetometer, and other embedded sensors	No	Yes	No	No	No	No	-App can record travel data such as position, speed, and route using multiple sensors embedded in the device, so does not require a GPS signal. -After completing the journey, participants are asked to answer short surveys about travel mode, travel cost, travel purpose etc. -This can be customised to ask research purpose questions. -App is very intuitive learning from the user's answers and travel behaviour to suggest modifications to journey -Maps are embedded in the app to help recall journey allowing users to correct a trip or modify information if displayed incorrectly.
6	TRavelVU	TrivectorAB (en.trivector.se/it-systems/travelvu/)	-Proprietary software -Free in the App Store	-A mobile application for collecting travel survey data using embedded sensors data and an advanced software algorithm to register trips and activities between trips. -Developed by a Swedish company specialising in transport, IT	Android and iOS	GPS, GSM, WiFi, Accelerometer, Magnetometer, and other embedded sensors	No	Yes	Yes	Yes	Yes	Yes	-App can automatically detect 7 travel modes and the register has the option to further choose 10 modes. -App can collect information on time, travel length, speed, and route for every travel leg split of the journey. -Maps are embedded in the app to show how transport system is used by different groups and also to help recall travel to modify incorrect information. -App does not have survey questions embedded but as it is highly customisable, this can be added to the design.

				systems, and business development									-As the app has not been used by any study yet, effective and accuracy cannot be determined. However, it has a 3/5 score in the app store.
S/N	**Name**	**Developer**	**Licence and Price**	**Overview**	**How It Works**								**Other Features**
					Operating System	**Sensors Used**	**Automatically Detecting Start/Stop**	**Automatically Detecting Travel**	**Detecting Travel Split Legs**	**Detecting Travel Mode**	**Detecting Travel Purpose**	**Detecting Travel Destination**	
7	Sense.DAT	DAT.Mobility (dat.nl/en/products/sensedat/)	-Proprietary software -Free in the App Store	-A smartApp that measures, analyse and store outdoor travel behaviour and experience data. -Developed by a Dutch company specialising in mobility monitoring, modelling, managing and planning	Android and iOS	GPS, GSM, WiFi, Accelerometer, Magnetometer, and other embedded sensors	Yes	Yes	Yes	Yes	Yes	Yes	-An intuitive app that learns from the user. -Each trip can be viewed, approved and corrected by the user due to its travel recall function. -The app uses all of its sensors to automatically detect travel time, origin and destination, travel mode and travel route. -App offers a sampling option that enables researchers to ask additional questions about actual travel behaviour making it highly customisable. -The effectiveness and accuracy has not been determined as the app does not have real world use in any study yet.
8	My Physical Activities (MPA)	-N/A -Most likely authors	-N/A -Can be obtained for free from the authors (presumably)	-An experimental smartphone app developed to detect and classify travel modes automatically into 5 -Authors are Xiaolu Zhou et al (2016)	Android	GPS and Accelerometer	No	Yes	Yes	Yes	No	No	-An experimental app tested on a small number of people 12 albeit achieving a 93.8% accuracy rating. -Designed to use a 3-layer classification to recognise travel modes to a very high accuracy (although this was after travel was reconstructed and mapped). -5 modes of walking, running, biking, in-vehicle, and stationary were designed to be detected -App does not include a questions sampling option.
9	MyExperience	-N/A -Most likely authors	N/A	-An app developed to record respondents' mood 30-60 mins before, immediately after and 60 mins later at the workplace after the commute.	Android and iOS	GPS	No	Yes	No	No	No	No	-This app does not measure the traditional travel information all other apps measure. However, it does offer significant advantages. -Questionnaires were embedded into the app which the respondents had to answer at the different time intervals mentioned. The

	-Margareta Friman et al (2017) set out to understand how work commutes change positive vs negative and active vs passive mood experienced after the commute.		questionnaires were short, taking 1 – 2 mins each to complete. -Respondents were notified when a new questionnaire was available with instruction on how to answer them. Reminders were also sent 30 mins after the first 2 time periods and 60 mins after the last in case respondents forget to complete the questionnaires. -The questionnaires embedded recorded mood, satisfaction with travel, positive critical incidents, non-travel related occurrence, and travel characteristics such as travel duration, travel mode and travel companion amongst others. -With the exception of mood (which had records taken in all of the instances), records of every other aspect were done immediately after the journey.

Source: Author

Based on the above information, the above smartphones applications are ranked according to their usability, features, and ease of procurement as follows;

1. Sense.DAT
2. TRavelVU
3. BetterPoints
4. MyExperience
5. SmartMo
6. MyPhysicalActivities
7. SbNavi
8. Nemo-Phone
9. rMove

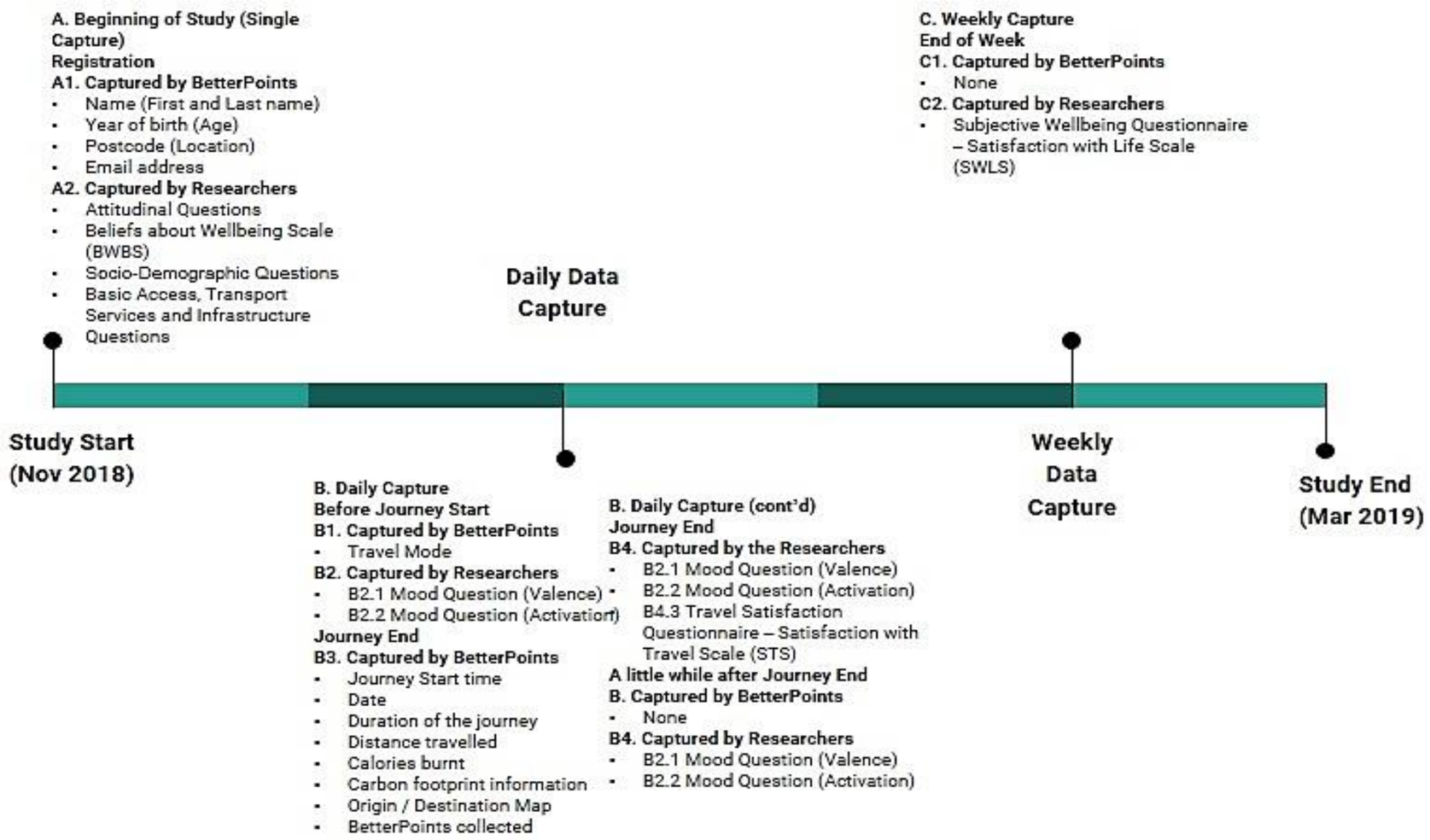
Additional Notes

Sense.DAT, TRavelVU and BetterPoints are very high on the list because their developers can easily be contacted, and the abundance of information available on their respective websites, although they may pose a challenge in terms of costs. Furthermore, the developers may be open to additions to the app in terms of gamification, embedding questionnaires, and some added features (for example, the MyExperience app features may also be included). MyExperience proposes a very different approach to the other apps on the list and may be worth pursing because it can be used to measure the after-effect question posited in the research.. MyPhysicalActivities is also ranked high because it is believed that the developers may be convinced to adding extra features especially with the app being experimental in nature. SmartMo would really benefit if it could be customised to include embedded questionnaires along with its existing features.

In sum, these apps have individual trade-offs due to their differences that would involve making the best use of whichever is available.

APPENDIX IV – APPENDIX TO CHAPTER 3 (RESEARCH DESIGN CONTEXT)

RESEARCH METHODS TIMELINE AND QUESTIONS



A. Beginning of Study

Registration

Two types of sign up. Email or Facebook

Email Sign-up

A1. Captured by BetterPoints

- Name (First and Last name)
- Year of birth (Age)
- Postcode (Location)
- Email address

Facebook Sign-up

Redirects to Facebook login and retrieves the above info from account.

A2. Captured by Researchers

- Attitudinal Questions
- Commuting Pattern
- Beliefs about Well-being Scale (BWBS)
- Socio-Demographic Questions
- Basic Access / Neighbourhood Quality, Transport Services and Infrastructure Questions

B. Daily Capture

Journey Start

B1. Captured by BetterPoints

- Travel Mode

B2. Captured by Researchers

- B2.1 Mood Question (Valence)
- B2.2 Mood Question (Activation)

During the journey

BetterPoints has an automatic tracking functions which enables the app to automatically record travel activity and information.

Journey End

B3. Captured by BetterPoints

- Journey Start time
- Date
- Duration of the journey
- Distance travelled
- Calories burnt
- Carbon footprint information
- Origin / Destination Map
- BetterPoints collected

B4. Captured by the Researchers

- B4.1 Mood Question (Valence)
- B4.2 Mood Question (Activation)
- B4.3 Travel Satisfaction Questionnaire – Satisfaction with Travel Scale (STS)

90 minutes after Journey End

B. Captured by BetterPoints

- None

B4. Captured by Researchers

- B4.1 Mood Question (Valence)
- B4.2 Mood Question (Activation)

C. Weekly Capture

End of the Week

C1. Captured by BetterPoints

- None

C2. Captured by Researchers

- Subjective Well-being Questionnaire – Satisfaction with Life Scale (SWLS)

Research Questions and Data Collected

S/N	Research Question	Data Collected
1	Is there any association between an individual's commuting behaviour and their subjective well-being?	Commuting behaviour measured with attitudinal and commuting patterns questionnaire; Subjective Well-being measured with the Satisfaction with Life Scale.
2	What role does an individual's commuting pattern and satisfaction with daily travel play on their subjective and overall well-being?	Commuting pattern measured with attitudinal and commuting patterns questionnaire; Daily travel satisfaction measured with the Satisfaction with Travel Scale;

		Subjective and Overall Well-being measured with the Satisfaction with Life Scale.
3	Is the individual's overall well-being influenced by accumulated effects of commuting?	Overall well-being measured by the Satisfaction with Life Scale; Accumulated effects of Commuting measured with a "commute impact" question in the Initial survey questionnaire.
4	To what extent does commuting behaviour influence other life domains especially work-life and family-life?	Commuting behaviour measured with attitudinal and commuting patterns questionnaire including other commuting variables such as travel time, mode etc.; Influence on other life domains (spill-over effects) measured by moods I and III questions (pre-and-post commutes surveys).
5	Has access to basic amenities, a good neighbourhood, and urban transportation infrastructure and resources influenced commuting patterns and behaviours?	Access to basic amenities etc. measured by basic access and neighbourhood quality questionnaire; Commuting pattern measured with attitudinal and commuting patterns questionnaire.
6	How has the socio-demographic conditions affected the commuting patterns and behaviours of individuals, and have these conditions affected their subjective well-being?	Socio-demographic variables measured with the Socio-demographic questionnaire; Commuting pattern measured with attitudinal and commuting patterns questionnaire; Subjective Well-being measured with the Satisfaction with Life Scale.

Source: Author

RESEARCH QUESTIONNAIRE				
S/N		**Questions**	**Measurement Scale**	**Frequency**
1	**Attitudinal and Commuting Patterns** To you, how true are the following statements?		7-point Likert Scale	Single capture; Initial Survey Questionnaire
Q1	ATT_COM_Ia	Commuting is boring	(1) Strongly disagree (2) Disagree (3) Somewhat disagree (4) Neither agree nor disagree (5) Somewhat agree (6) Agree (7) Strongly agree	
Q2	ATT_COM_Ib	Commuting makes me nervous		
Q3	ATT_COM_Ic	I often worry about my safety when I commute		
Q4	ATT_COM_Id	My commute is a useful transition between home and work (and vice versa)		
Q5	ATT_COM_IIa	I am uncomfortable being around people I do not know when I commute		
Q6	ATT_COM_IIb	Having to wait makes me feel like I am wasting my time		
Q7	ATT_COM_IIc	We need more public transportation even if it means I pay more in taxes		
Q8	ATT_COM_IIIa	A car is nothing more than a convenient way to get around		
Q9	ATT_COM_IIIb	For improved environmental quality and sustainability, I am willing to limit auto-travel and/or pay extra to use electric or clean-fuel vehicles		
Q10	ATT_COM_IVa	I would like to spend some time each week on myself		
Q11	ATT_COM_IVb	I would like to spend more time on work		
Q12	ATT_COM_IVc	I would like to spend more time with family and friends		
Q13	ATT_COM_IVd	I would like to spend more time on environmental, social, religious or voluntary causes		
2	**Beliefs about Well-being** I feel the experience of well-being and the good life necessarily involves:		7-point Likert Scale	Single capture; Initial Survey Questionnaire
Q14	BWBS_Ia	A great amount of pleasure	(1) Strongly disagree (2) Disagree (3) Somewhat disagree (4) Neither agree nor disagree (5) Somewhat agree (6) Agree (7) Strongly agree	
Q15	BWBS_Ib	Pleasurable experiences		
Q16	BWBS_Ic	Experiencing euphoria and pleasure		
Q17	BWBS_Id	Experiencing a great deal of sensual pleasure		
Q18	BWBS_IIa	A lack of unpleasant experiences		
Q19	BWBS_IIb	A lack of painful experiences		
Q20	BWBS_IIc	Not experiencing negative emotions		
Q21	BWBS_IId	Not experiencing hassles		
Q22	BWBS_IIIa	Living in ways that benefit others		
Q23	BWBS_IIIb	Making the world a better place		
Q24	BWBS_IIIc	Being a positive influence within the community		
Q25	BWBS_IIId	Contribution to society		
Q26	BWBS_IVa	Working to achieve one's true potential		
Q27	BWBS_IVb	The identification and cultivation of one's strengths		
Q28	BWBS_IVc	The exertion of effort to meet life's challenges		
Q29	BWBS_IVd	A high degree of self-knowledge		
3a	**Mood Questions I** How are you feeling right now?		7-point Likert Scale	Daily capture; before journey start (between 5:30AM and 9:00AM for morning commute and repeats
Q30	VAL1_Q1	Relating to an unpleasantness/pleasantness	(-3) Very Sad (-2) Depressed	

			(-1) Displeased (0) Neutral (1) Pleased (2) Very Glad (3) Joyful	between 3:30PM and 7:00PM for evening commute)
Q31	ACT1_Q2	Relating to a quiet/excitement experience	(-3) Very Passive (-2) Sleepy (-1) Dull (0) Neutral (1) Awake (2) Lively (3) Very Active	
3b	**Mood Questions II** How are you feeling right now?		7-point Likert Scale	Daily capture; at the end of every journey to work (morning) and from work (evening)
Q32	VAL2_Q1	Relating to an unpleasantness/pleasantness	(-3) Very Sad (-2) Depressed (-1) Displeased (0) Neutral (1) Pleased (2) Very Glad (3) Joyful	
Q33	ACT2_Q2	Relating to a quiet/excitement experience	(-3) Very Passive (-2) Sleepy (-1) Dull (0) Neutral (1) Awake (2) Lively (3) Very Active	
3c	**Mood Questions III** How are you feeling right now?		7-point Likert Scale	Daily capture; a little while after journey end (between 11:30AM and 1:30PM for morning commute and repeats between 8:00PM and 10:00PM for evening commute).
Q34	VAL3_Q1	Relating to an unpleasantness/pleasantness	(-3) Very Sad (-2) Depressed (-1) Displeased (0) Neutral (1) Pleased (2) Very Glad (3) Joyful	
Q35	ACT3_Q2	Relating to a quiet/excitement experience	(-3) Very Passive (-2) Sleepy (-1) Dull (0) Neutral (1) Awake	

			(2) Lively (3) Very Active	
4	**Travel Satisfaction**		7-point Likert Scale	Daily capture; at the end of every journey to and from work (same time as Mood Questions II)
Q36	PAND_Q1	Relating to an enthusiasm/boredom experience, how would you rate the experience of your journey?	(-3) Very Bored (-2) Tired (-1) Fed Up (0) Neutral (1) Alert (2) Engaged (3) Enthusiastic	
Q37	PDNA_Q2	How would you rate the experience of your just concluded journey with regard to a stressed/relaxation experience?	(-3) Stressed (-2) Worried (-1) Hurried (0) Neutral (1) Calm (2) Relaxed (3) Confident	
Q38	CE_Q3	How you would judge the overall experience of your journey?	(-3) It was the worst I can think of (-2) It was of a low standard (-1) It did not work out well (0) It was neither good nor bad (1) It worked out well (2) It was of a high standard (3) It was the best I can think of	
5	**Subjective Well-being** Considering the past week's activities, please indicate how you feel:		7-point Likert Scale	Weekly capture; end of the week
Q39	SWLS_a	In most ways, my life is close to my ideal	(1) Strongly disagree (2) Disagree (3) Somewhat disagree (4) Neither agree nor disagree (5) Somewhat agree (6) Agree (7) Strongly agree	
Q40	SWLS_b	The conditions of my life are excellent		
Q41	SWLS_c	I am satisfied with my life		
Q42	SWLS_d	So far, I have gotten the important things I want in life		
Q43	SWLS_e	If I could live my life over, I would change almost nothing		
6	**Socio-Demographic Information**		Multiple Scales	Single capture; Initial Survey Questionnaire
Q44	DEMO_Q1	What gender do you identify as?	(1) Male (2) Female	
Q45	DEMO_Q2	How would you describe your household type?	(1) Single household without children (2) Single household with children (3) Couple with children (4) Couple without children	
Q46	DEMO_Q3	Including yourself, how many people live in your household?	_____	

Q47	DEMO_Q4	Please, indicate below the group you would place your household income in the past 12 months from all sources, before tax and other deductions?	(1) Under £10,399 (2) £10,400 - £15,599 (3) £15,600 - £20,799 (4) £20,800 - £25,999 (5) £26,000 - £31,199 (6) £31,200 - £36,399 (7) £36,400 - £41,599 (8) £41,600 - £46,799 (9) £46,800 - £51,999 (10) £52,000 - £77,999 (11) £78,000 - £103,999 (12) £104,000 above (13) I prefer not to say
Q48	DEMO_Q5	How would you describe your highest level of education qualification?	(1) GCSEs (D-G) – NVQ L1 (2) GCSEs (A-C) – NVQ L2 (3) A Levels (including BTEC Nationals) – NVQ L3 (4) HNC/HND/Foundation Degree – NVQ L4 (5) Bachelor's Degree Years 1 & 2/Other Professional Degree – NVQ L5 (6) Bachelor's (Honours) Degree – NVQ L6 (7) Master's Degree (MSc, MA, MBA, LLM) – NVQ L7 (8) Doctoral Degree (PhD) – NVQ L8
Q49	DEMO_Q6	What is your current employment status?	(1) Full-time (2) Part-time (3) Non-employed student (4) Unemployed
Q50	DEMO_Q7	What occupational category best describes your work?	(1) Homemaker (2) Service/Repair (3) Sales (4) Production/Construction/Craft (5) Manager/Administrator (6) Clerical/Administrative Support (7) Professional/Technical (8) Government/Civil Service (9) Other, please specify:_____
Q51	DEMO_Q8	What ethnicity do you identify as?	(1) White Welsh / English / Scottish / Northern Irish / British (2) White Irish (3) White Gypsy or Irish Traveller (4) Any other White background, please describe:_____ (5) Mixed White and Black Caribbean (6) Mixed White and Black African (7) Mixed White and Asian (8) Any other Mixed/Multiple ethnic background, please describe:_____ (9) Black/African/Caribbean/Black British African (10)Black/African/Caribbean/Black British Caribbean

			(11) Any other Black/African/Caribbean background, please describe:_____ (12) Asian/Asian British Indian (13) Asian/Asian British Pakistani (14) Asian/Asian British Bangladeshi (15) Asian/Asian British Chinese (16) Any other Asian background, please describe:_____ (17) Arab / Arab British (18) Any other ethnic group, please describe:_____	
Q52	DEMO_Q9	How many hours do you work in a week?	_____	
Q53	DEMO_Q10	How many cars do you have in your household?	_____	
Q54	DEMO_Q11	Do you have a weekly or monthly public transport travel card?	(1) Yes (2) No	
Q55	DEMO_Q12	To what extent do you feel your daily commute impacts your overall stress levels and/or well-being?	(1) A great deal (2) A lot (3) A moderate amount (4) A little (5) None at all	
7.	**Basic Access, Transport Services and Infrastructure Questions** How would you rate your:		7-point Likert Scale	Single capture; Initial Survey Questionnaire
Q56	BAS_ACC_Ia	Neighbourhood road quality	(1) Extremely dissatisfied (2) Moderately dissatisfied (3) Slightly dissatisfied (4) Neither satisfied nor dissatisfied (5) Slightly satisfied (6) Moderately satisfied (7) Extremely satisfied	
Q57	BAS_ACC_Ib	Neighbourhood parking spaces		
Q58	BAS_ACC_Ic	Neighbourhood public transport condition		
Q59	BAS_ACC_IIa	Neighbourhood accessibility to a GP or dentist		
Q60	BAS_ACC_IIb	Neighbourhood accessibility to a park, or a safe place to relax or exercise		
Q61	BAS_ACC_IIc	Neighbourhood accessibility to convenience stores		
Q62	BAS_ACC_IIIa	Neighbourhood street lighting condition		
Q63	BAS_ACC_IIIb	Neighbourhood state of security		
Q64	BAS_ACC_IIIc	Overall Neighbourhood satisfaction		
Q65	BAS_ACC_Q2	How long have you lived in this neighbourhood (in years)?	_____	
Q66	BAS_ACC_Q3	Did the availability of a personal vehicle determine your choice of moving to this neighbourhood?	(1) Yes (2) No	

RESEARCH INVITATION

INITIAL WELCOM STUDY INVITE

WELCOM is a study to investigate the links across commuter patterns, travel satisfaction, subjective and overall well-being.

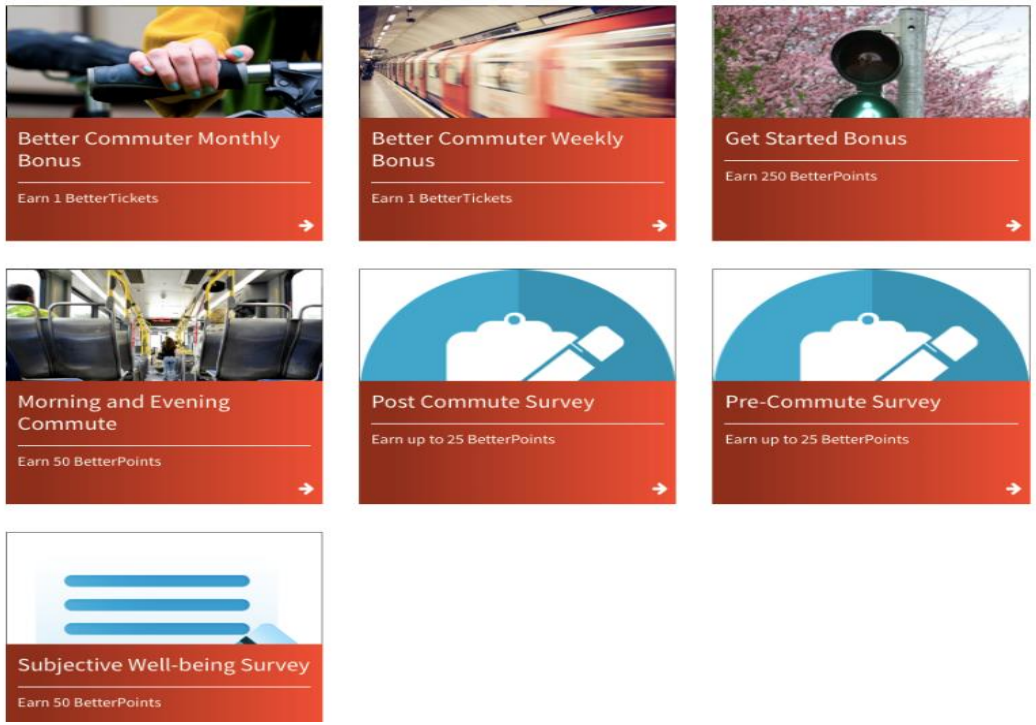
The study is designed to capture the daily patterns of commuters in Cardiff, but most importantly to elicit their daily satisfaction with commuting and how that feeds into their overall subjective well-being.
This study has been approved by the ethics committee of the School of Geography and Planning, Cardiff University, and is in fulfilment of the award of a doctoral degree for Dami Akosile, a postgraduate research student in the school.

The data will be collected by BetterPoints (www.betterpoints.co.uk) over a 6-8-week period from 5 November 2018.

Participants will need to provide at least 3 days of commuting activities within a week (preferably 2-weekdays and 1-weekend day, if possible) for a period of 4 weeks.

All that is needed to take part is a smartphone equipped with mobile data services and the BetterPoints app.

Also, there's a reward scheme for participants!
As you complete your journey and answer questions, you will be awarded points. You'll also be entered into weekly and monthly draws for bonus points which can be redeemed for vouchers and gift cards to popular high street stores (amongst which are Topshop, Curry's PC World, Burton, Miss Selfridge, Sainsbury's, Tesco, John Lewis, Asda, and Pizza Express to mention a few). More information can be found in the **'Redeem'** section on the app.
Please see below a breakdown of rewards that can be earned.



For a detailed breakdown of how activities are rewarded, navigate to the **"Programmes"** tab when you download the app and click on the **Welcom Study**. You can then scroll down to see each activity reward and click through for more details.

REVISED WELCOM STUDY INVITE

WELCOM Study
Investigating links across commuting, travel satisfaction and well-being in the Cardiff Region

School of Geography and Planning
Cardiff University

- This research study is aimed at capturing the daily patterns of commuters and their travel satisfaction in the Cardiff Region. Most importantly, we seek to better understand how commuting feeds into travellers' well-being.
- We need you to participate in at least 3 full days of commuting activity including providing your responses to the three survey questions for each journey, morning and evening. Preferably 2 weekdays and 1 weekend day would be nice (if possible). These can be consecutive or over a period of time.
- To participate in this study, please download the BetterPoints App available on the AppleStore (iOS devices) or GooglePlay (Andriod devices) and register using the '**welcomcardiff**' referral code. Following registration, navigate to 'Programmes' and join the Welcom Study.
- Every participant who records at least 3 days of activities/surveys on the app will be awarded 10,000 BetterPoints worth £10 within 10 days of the end of the programme on March 15th, 2019. You can redeem these points for e-vouchers to major high-street stores (e.g. John Lewis, PC World, Tesco, Sainsbury's amongst others) on the app.
- You can also earn BetterPoints through our 'Refer a Friend' incentive - Refer a friend and you both get 250 BetterPoints each when your friend registers* (*For up to 5 friends referred).

The study has received ethics approval from Cardiff University's ethics committee and all responses will be strictly confidential and anonymised.
Should you have any queries, please do not hesitate to contact us at welcom@cardiff.ac.uk.

For more information on the study, please visit Welcom Study Cardiff.

Please feel free to forward this invite to colleagues, family, and friends who may be interested in participating.

Thank you for your help!

WELCOM STUDY INSTRUCTION

To join and participate in the study, please follow the steps outlined below.

NOTE:
For us to achieve the desired results, we understand that the whole survey exercise may be a bit taxing. However, we assure you that we have endeavoured to make the whole exercise the least intrusive as possible. Furthermore, it is important that the surveys are answered when due as this is essential to the study. See numbers 4, 5, 6,7, and 8 below for more details.

1. **Download** the **BetterPoints** app from the **PlayStore (Android devices) or App Store (iOS devices)** to your mobile data enabled smartphone. (Just type in 'betterpoints' in the search bar of your device's app store).

2. Complete the in-app registration and activate the app via the link sent to your email address.
IMPORTANT: Please enter the referral code '**WelcomResearch**' when prompted during registration. This would allow you to access the Welcom study on the app when you navigate to the programmes tab after registration. And if you forget to enter this code during registration, you can do so by clicking on the **'add referral code'** option in the main menu or simply contact customer care by leaving a message via the **'help'** option.

3. After the activation process, open the BetterPoints app, navigate to the **'Programmes'** menu tab and join the **Welcom Study**.

4. Go back to the **'Timeline'** tab. You should see a notification on the timeline asking you to "please answer our initial survey to get started". Click on that notification (you will be taken to an external website - Qualtrics) and answer the survey questions. This should only take you about 8 minutes to complete. You can also access the initial survey via the link in the email sent by BetterPoints after registration.

5. Each day you'll be asked a series of **pre-commute** survey questions: These will be pushed to your phone **every morning (for your morning commute) and every evening (for your evening commute).** A message about them will appear in your BetterPoints timeline. Please click through the message and answer the questions before you start your commute.

6. As you set out to start and end your daily commute, please choose a mode of travel by **logging it in the BetterPoints app**. Just click the play button in the upper right-hand corner of the app and start your activity. Don't forget to press 'complete' and answer the questions after you travel. Please remember to complete this for **both morning and evening commutes**.

7. Also, you'll be asked a series of **post-commute** questions daily. Please answer these a little while after you complete both your morning and evening journeys. As above with the pre-commute questions, these will be pushed to your phone and a message about them will appear in your BetterPoints timeline. Please click through the message and answer the questions.

8. Finally, once every week, you will be required to complete a **Subjective Well-being** survey. A message will be pushed to your timeline reminding you. Please click through the message to complete this survey.

Please feel free to forward this invite to colleagues, family, and friends who may be interested in participating.

We thank you for your help.

Should you have any queries, please do not hesitate to contact us at welcom@cardiff.ac.uk.

APPENDIX V – APPENDIX TO CHAPTER 3 (ETHICS APPROVAL FORM)

Cardiff School of Geography and Planning

SUBMISSION OF ETHICAL APPROVAL FORMS

Staff and MPhil/PhD Projects

ALL FORMS FOR ETHICAL APPROVAL **MUST** BE SUBMITTED TO THE SECRETARY OF THE SCHOOL ETHICS COMMITTEE IN GOOD TIME (PREFERABLY 2 WEEKS) BEFORE THE NEXT SCHEDULED SREC MEETING

An electronic version must to emailed to Ethan Lumb, Secretary of Ethics Committee LumbE@cardiff.ac.uk / Tel Ext: 76412/ Room 2.54 Glamorgan Building as a work attachment, bearing relevant staff and/or PGR Student signatures.

Title of Project:

Commuting and the Well-being

Name of researcher(s):

Dr. Dimitris Potoglou

Damilola Akosile

Date: **Signature of lead researcher:**

20/08/2018

Student project

Anticipated Start Date of Fieldwork: 01/10/2018

Recruitment Procedures:		**Yes**	**No**	**N/A**
1	Does your project include children under 16 years of age?		**X**	
2	Have you read the Child Protection Procedures below?	**X**		
3	Does your project include people with learning or communication difficulties?		**X**	
4	Does your project include people in custody?		**X**	
5	Is your project likely to include people involved in illegal activities?		**X**	
6	Does your project involve people belonging to a vulnerable group, other than those listed above?		**X**	
7	Does your project include people who are, or are likely to become your clients or clients of the department in which you work?		**X**	
8	Does your project include people for whom English / Welsh is not their first language?		**X**	

9	Have you read the Data Protection Policy below?	**X**		
10	Have you read the Health & Safety Policy below?	**X**		

*** Cardiff University's Child Protection Procedures:**

https://www.cardiff.ac.uk/__data/assets/pdf_file/0009/995094/Safeguarding-Policy-October-2017.pdf

If you have answered 'yes' to any of the above questions please outline (in an attached ethics statement) how you intend to deal with the ethical issues involved

Data Protection:		**Yes**	**No**	**N/A**
11	Will you tell participants that their participation is voluntary?	**X**		
12	Will you obtain written consent for participation? If "No" please explain how you will be getting informed consent.		**X**	
13	If the research is observational, will you ask participants for their consent to being observed?	**X**		
14	Will you tell participants that they may withdraw from the research at any time and for any reasons?	**X**		
15	Will you give potential participants a significant period of time to consider participation?	**X**		

If you have answered 'no' to any of these questions please explain (in your ethics statement) the reasons for your decision and how you intend to deal with any ethical decisions involved

Possible Harm to Participants:		**Yes**	**No**	**N/A**
16	Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		**X**	
17	Is there any realistic risk of any participants experiencing a detriment to their interests as a result of participation?		**X**	

Research Governance:		**Yes**	**No**	**N/A**
18	Does your study include the use of a drug? You will need to contact Research Governance before submission (resgov@cf.ac.uk)		**X**	
19	Does the study involve the collection or use of human tissue? You will need to contact the Human Tissue Act team before submission (hta@cf.ac.uk)		**X**	

If there are any risks to the participants you must explain in your ethics statement how you intend to minimise these risks

Data Protection:		**Yes**	**No**	**N/A**
20	Will any non-anonymised and/or personalised data be generated and/or stored?		**X**	
21	Will you have access to documents containing sensitive[1] data about living individuals?	**X**		
	If "Yes" will you gain the consent of the individuals concerned?	**X**		

Data protection Act Guidelines

https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection

If there are any other potential ethical issues that you think the Committee should consider please explain them in an ethics statement. It is your obligation to bring to the attention of the Committee any ethical issues not covered on this form.

Health and Safety:	**Yes**
Does the research meet the requirements of the University's Health & Safety policies? https://www.cardiff.ac.uk/__data/assets/pdf_file/0008/89405/SHWE-Policy-Statement-English.pdf	***X***
Does the study involve the collection or use of human tissue (including, but not limited to, blood, saliva and bodily waste fluids)? If yes, a copy of the submitted application form and any supporting documentation must be emailed to the Human Tissue Act Compliance Team (HTA@cf.ac.uk). A decision will only be made once these documents have been received.	

Risk Assessment Has the relevant risk assessment form been completed? Research abroad, complete: \\Geoplpool1\geopl\SHARED\05 - RESEARCH\ETHICS\SREC Forms & guidance\SREC Risk Assessment Forms\RA_Abroad_Example.doc Research in the UK, complete: \\Geoplpool1\geopl\SHARED\05 - RESEARCH\ETHICS\SREC Forms & guidance\SREC Risk Assessment Forms\RA_UK_Example.doc Research on campus, complete: \\Geoplpool1\geopl\SHARED\05 - RESEARCH\ETHICS\SREC Forms & guidance\SREC Risk Assessment Forms\RA_Campus_Example.doc	**Yes**	**No** **X**

If yes, ensure a copy is submitted with the completed application		
If no, explain why a risk assessment form is not necessary… This is because all of our 'fieldwork' data would be collected online and there's no physical field study being undertaken.		

Please provide following information for the committee:

Funding Source

What are the main objectives of this research?

The main objective of this research is to design and implement an innovative approach to capture daily travel patterns of commuters in Cardiff, eliciting their daily travel satisfaction and its impacts on their subjective well-being via a smartphone-based application.

Who are the research participants?

The participants in the study would be commuters within the City of Cardiff. However, the focus would be on staff members (and some postgraduate students) in Cardiff University, and workers from one or two organisations within the city.

What methodologies will you be using?

The study will be implementing a real-time smartphone-based data collection tool to better capture temporal variations of the effects of commuting and travel satisfaction on subjective and overall well-being.

The data collection will be conducted in association with BetterPoints.org, a smartphone app and behavioural change organisation. Participants must register to the research programme, choose their travel mode when starting the app and stop it at the end of the journey. The distance travelled, duration of travel, calories burnt, carbon footprint and travel time are recorded at the completion of the journey.

Building on the capabilities of the BetterPoints app, the research would effectively establish the relationship across commuting, travel satisfaction, subjective and overall well-being using the app and ad-hoc surveys embedded in it. The research will ask respondents to take a travel satisfaction survey immediately after each journey to and from work. A mood-based question will be asked before, immediately after and 90 minutes following every journey to the workplace and back home. Respondents will also complete the appropriate well-being scales on a weekly basis. Information relating to respondents' socio-demographics, neighbourhood quality and existing transport infrastructure will be collected at the end of the survey period.

Ethics Statement

If your answers to questions 1-19 raise any ethical issues, please explain here how you will deal with them.

In response to the ethical issues raised earlier, the following outlines the steps to be taken. To start with, respondents would be required to consent to participating in the research before downloading the mobile application used in the study. This would be after they must have read and agreed to the terms of the research. All primary data including commuting patterns and survey data will be stored, managed and handled by BetterPoints who are in compliance with the recent General Data Protection Regulation (GDPR) that took effect from 25 May 2018. Evidence from the findings would be anonymized and then transferred to us for further processing and analysis. These data will be stored as per Cardiff University's practises working with the University's Information Technology team to ensure that the data are safely stored and are accessed only by us. Finally, respondents would be free to request that their data be deleted at any time of the study.

All of these would be carefully explained to the respondents at the start of the study via the invitation email.

Any changes to the nature of the project that result in the project being significantly different to that originally approved by the committee must be communicated to the Ethics Committee immediately.