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Hendry, Alexander David

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Southern Cross University School of Business and Tourism

Usage Behaviour of a Personal Carbon Monitoring System

Alexander Hendry

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Thesis Declaration

I certify that the work presented in this thesis is, to the best of my knowledge and belief, original, except as acknowledged in the text, and that the material has not been submitted, either in whole or in part, for a degree at this or any other university.

I acknowledge that I have read and understood the University's rules, requirements, procedures and policy relating to my higher degree research award and to my thesis. I certify that I have complied with the rules, requirements, procedures, and policy of the University (as they may be from time to time).

Name: Alex Hendry

Date: 8th December 2019

Signature:

Abstract

Anthropogenic climate change is currently the greatest threat faced by human society and the biodiversity of the planet and therefore requires urgent and immediate action. The theory behind anthropogenic climate change and its connection with the carbon emissions associated with fossil fuel usage has been well documented. Personal Carbon Trading (PCT) is a generic term used to describe several similar conceptual downstream schemes that aim to reduce carbon emissions at an individual level. However, the literature surrounding PCT is theoretical in nature, and there does not appear to be any evidence outside of the current research of a Personal Carbon Trading System (PCTS) or a Personal Carbon Monitoring System (PCMS) having been evaluated across a whole community. This research seeks to fill the gap in the literature in this respect.

The voluntary Norfolk Island Carbon and Health Evaluation (NICHE) PCMS was designed and developed by the author based on the most detailed conceptual PCT schemes. For 15 months, the NICHE PCMS monitored the carbon emissions produced by the fossil fuel usage (petrol, diesel, electricity, and gas) for 219 households on Norfolk Island (27% of total households) and provided a carbon emission reduction target based on household size. Survey instruments that were open to all households on Norfolk Island were administered before and after the NICHE PCMS trial to gather attitudinal and behavioural data across a range of areas. Based on the statistical analysis of this data, the research reported in this thesis examines:

- The changes in attitudes towards PCT resulting from the NICHE PCMS trial;

- The differences in attitudes towards PCT between those who volunteered for the NICHE PCMS trial and those who did not; and
- The factors that influenced the usage of the NICHE PCMS.

The conceptual model underpinning the research was adapted from the Extended Technology Acceptance Model (TAM2) that measures user acceptance and usage behaviour of information systems. Additional constructs included in the model were identified in the review of the literature covering attitudes and behaviours towards the environment, carbon emissions, climate change, health, and PCT.

Findings from the research show that there were significant changes in attitudes and behaviours towards the environment, carbon emissions, and climate change following the NICHE PCMS trial, and these attitudes and behaviours predicted higher levels of variance in attitudes toward PCT. Individuals who participated in the trial (PCMS users) were significantly more likely to believe in anthropogenic climate change and display positive attitudes towards PCT than those that did not participate (non-PCMS users). For PCMS users, their attitudes towards PCT were predicted by their attitudes towards the environment, carbon emissions, and climate change, whereas the predictors in attitudes towards PCT for non-PCMS users were attitudes regarding their health and body weight. Finally, the significant factors that predicted the usage of the NICHE PCMS were *Carbon Consciousness*, *Consumer Consciousness*, *Voluntariness*, *Perceived Usefulness*, *Perceived Ease of Use*, and *Intention to Use*.

The research presented herein represents the first study of its kind to trial a PCMS, identify the differences in attitudes and behaviours between those who would voluntarily use a PCMS and those who would not, and determine the factors that predict voluntary usage of a PCMS.

While technology acceptance models have been applied to a range of information systems, mainly in a workplace context, there is no evidence outside of the current research of a technology acceptance model being used to examine usage of a PCMS and determine its validity for household acceptance studies.

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List of Publications

Publications

Webb, G., Hendry, A., Armstrong, B., McDermott, R., Swinburn, B., & Egger, G. (2014). Exploring the effects of a personal carbon trading (PCT) system on carbon emission and health issues: a preliminary study on Norfolk Island. *International Technology Management Review*, 4(1), 1-11. doi:10.2991/itmr.2014.4.1.1

Hendry, A., Webb, G., Wilson, A., Armstrong, B., McDermott, R., Smart, B., & Egger, G. (2015). Influences on the intentions to use a personal carbon trading system (NICHE – The Norfolk Island Carbon Health Evaluation Project). *International Technology Management Review*, 5(2), 105-116. doi:10.2991/itmr.2015.5.2.5

Hendry, A., Armstrong, B., Egger, G., Webb, G., & Smart, W. (2016). Gender differences in intentions to use a personal carbon trading system. *International Technology Management Review*, 6(2), 37-49. doi:10.2991/itmr.2016.6.2.2

Conference Abstracts

Hendry, A., & Webb, G. (2013). Early findings of the NICHE project. Paper presented at the Australian Lifestyle Medicine Association Conference, Manly, NSW, Australia.

Hendry, A., (2013) Influences on Attitudes to a Personal Carbon Trading System, Paper presented at the 24th Australian Conference on Information Systems, RMIT University, Melbourne, Australia

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Abbreviations

ARC	Australian Research Council
BMI	Body Mass Index
$GtCO_2e$	Gigatonnes Carbon Dioxide Equivalent
CaT	Cap and Trade
C&S	Cap and Share
CHSS	Carbon, Health, and Savings System
CRAGs	Carbon Rationing Action Groups
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CFA	Confirmatory Factor Analysis
Defra	Department for Environment, Food and Rural Affairs (UK)
DTQ	Domestic Tradable Quotas
EFA	Exploratory Factor Analysis
EU ETS	European Union Emissions Trading Scheme
GHG	Green House Gas
HHCT	Household Carbon Trading
IPCC	Intergovernmental Panel on Climate Change
KMO	Kaiser-Meyer-Olkin Measure of Sampling Adequacy
kWh	Kilowatt-Hour
MRV	Monitoring, Reporting, and Verification
MW	Megawatts
NIA	Norfolk Island Legislative Assembly
NICHE	Norfolk Island Carbon and Health Evaluation
NGOs	Non-Governmental Organisations
PCA	Personal Carbon Allowances
PCMS	Personal Carbon Monitoring System
PCT	Personal Carbon Trading
PCTS	Personal Carbon Trading System
POS	Point of Sale

PAF	Principal Axis Factoring
PCA	Principal Component Analysis
Q-Q plot	Quantile-Quantile Plot
RF	Radiative Forcing
SEM	Structural Equation Modelling
TAM	Technology Acceptance Model
TAM2	Technology Acceptance Model 2
TAM3	Technology Acceptance Model 3
tCO_2/year	Tonnes of Carbon Dioxide a Year
TRA	Theory of Reasoned Action
TEQ	Tradable Energy Quotas
UNFCCC	United Nations Framework Convention on Climate Change
UTAUT	Unified Theory of Acceptance and Use of Technology
WHO	World Health Organisation
WWF	World Wide Fund for Nature

Chapter 1 - Introduction

1.1 Overview of the Research

Personal Carbon Trading (PCT) is a generic term that is used to describe several proposed schemes that aim to reduce household carbon dioxide emissions. The Norfolk Island Carbon and Health Evaluation (NICHE) project was established to trial a voluntary Personal Carbon Trading System (PCTS) and investigate its public acceptability and effects on health and the environment. Due to the lack of support from the banking sector, it was not possible to implement the carbon trading component of a PCTS (see Section 1.4.2). Therefore, a Personal Carbon Monitoring System (PCMS) was trialled that represented several other significant aspects of a PCTS that were identified in the literature including the use of a carbon card, the production of carbon footprint statements, carbon allowances, and the identification of a carbon footprint target. The research reported in this thesis aims to identify:

- The changes in attitudes and behaviours resulting from a voluntary PCMS trial;
- The differences in attitudes and behaviours between those who would voluntarily use a PCMS and those who would not; and
- The factors that predict voluntary PCMS usage and acceptance;

As a result, the research aims to produce a validated model that has the potential to provide future researchers with a basis to predict PCMS usage and acceptance in a broader population sample.

1.2 Background to the Research

Since the industrial revolution, the concentration of carbon dioxide in the atmosphere has increased by almost 40%, primarily owing to the burning of fossil fuels for transport, electricity and industry (IPCC, 2013, p. 9). It is theorised that the increase in carbon dioxide in the atmosphere has already led to significant and discernible changes in the climate across the globe (U.S. Environmental Protection Agency, 2016; NASA, 2017b). It is widely agreed that carbon emissions (used as a shorthand for the technically correct term carbon dioxide emissions throughout this thesis) must be limited in order to mitigate anthropogenic climate change and the most effective way to accomplish this is to establish a carbon price (London School of Economics and Political Science, 2018). The main two proposals to date that have been put forward to establish a carbon price are a carbon tax and cap-and-trade, sometimes referred to as emissions trading (IPCC, 2018, p. 152).

A carbon tax is a tax that is levied on fossil fuels based on their carbon content, thereby increasing their cost, incentivising the use of less carbon-intensive alternatives, and reducing demand. A cap-and-trade scheme sets a cap on carbon emissions, and tradable permits are created for the allowable carbon budget that are auctioned or allocated to polluters (High-Level Commission on Carbon Prices, 2017, pp. 10-11). The main advantage of a carbon tax is that the carbon price is known in advance, but the reduction in emissions is uncertain. In contrast, for cap-and-trade, the reduction in emissions is known in advance, but the carbon price is uncertain (Weitzman, 2015).

As of April 2019, 28 cap-and-trade and 29 carbon tax initiatives have been implemented, capturing around 11 gigatons of carbon dioxide equivalent ($GtCO_2e$), or approximately 20 per cent of global emissions (World Bank, 2019, p. 9). The largest, the European Union Emissions Trading Scheme (EU ETS), operates in all 28 EU countries as well as Norway, Liechtenstein, and Iceland and is the only multinational carbon pricing initiative currently in operation (European Commission, 2015). The remaining carbon price initiatives are implemented across the following jurisdictional size ranges (World Bank, 2019):

- National initiatives, e.g., the Japanese carbon tax;
- Sub-national initiatives across multiple regions, e.g., the Regional Greenhouse Gas Initiative (RGGI) that operates in the states of New York, Connecticut, Massachusetts, Delaware, Maryland, Maine, Vermont, New Hampshire, and Rhode Island in the United States;
- Sub-national initiatives across a single region, e.g., the California Cap-and-Trade Program; and
- Single city initiatives, e.g., the Beijing Pilot Emissions Trading Scheme.

The share of carbon emissions captured by the various carbon price initiatives in their jurisdiction ranges from approximately 85% for the Quebec Cap-and-Trade System and the California Cap-and-Trade Program, to less than 5% for the Spanish carbon tax and the Estonian carbon tax due to exemptions for some producers or industries, or overlapping carbon pricing initiatives (Partnership for Market Readiness, 2017a; International Carbon Action Partnership, 2019; World Bank, 2019).

In theory, for both carbon pricing initiatives, the point of regulation can be applied at any segment of the supply chain, from producers and importers upstream, to generators and distributors midstream, to consumers downstream (Mansur, 2011). Upstream regulation limits the number of entities that need to be monitored (Metcalf & Weisbach, 2009, p. 501), requires less administration, and has lower monitoring, reporting, and verification (MRV) costs (Mansur, 2011, pp. 184-185; Goulder & Schein, 2013, pp. 11-12; Partnership for Market Readiness, 2017a; Coria & Jaraitė, 2019, p. 996). However, upstream regulation has the potential for carbon leakage to an unregulated section of the economy (Bushnell & Mansur, 2011; Mansur, 2011, p. 184) and can create a competitive disadvantage between regulated and unregulated competitors (Goulder & Schein, 2013, p. 9). In practice, most carbon taxes regulate upstream and midstream, whereas, for cap-and-trade, the point of regulation is generally downstream (Partnership for Market Readiness, 2017a; International Carbon Action Partnership, 2019).

Various studies have shown that households produce approximately 40% of direct carbon emissions, and upwards of 60% of indirect carbon emissions (Hertwich & Peters, 2009; Wilson, Tyedmers, & Spinney, 2013; Parag & Fawcett, 2014; Ivanova et al., 2016). While most of the cap-and-trade initiatives in operation regulate downstream, they all contain inclusion thresholds and only target large carbon emitters, and thus exempt households from regulation (International Carbon Action Partnership, 2019). One of the main proposals put forward to reduce household carbon emissions is PCT (Hendry et al., 2015). Fawcett (2010a, p. 329) defines PCT as a generic term used to describe several proposed downstream cap-and-trade schemes (see Section 2.2.4.1) that aim to reduce household carbon emissions by allocating equal-per-capita carbon emission allowances to individuals to meet a national carbon budget. The carbon allowances are surrendered for carbon usage resulting from household energy use and personal travel. The carbon allowances are also tradable, thus allowing individuals who require additional allowances beyond their initial allocation to purchase unused allowances from those who do not use their full allocation. Over time, the number of allowances allocated would contract in order to reduce carbon emissions.

Proponents argue that PCT is different from any of the current carbon pricing initiatives that operate at a distance from the individual, and do not communicate the significance of different decisions on carbon emissions (Fawcett & Parag, 2010a, p. 329). PCT provides frequent feedback in the form of a carbon statement (Fawcett, 2010b), empowering individuals to take control over their own carbon emissions (Parag & Strickland, 2011, pp. 4-5), and may lead to mental carbon budgeting, thereby resulting in more significant carbon savings (Capstick & Lewis, 2010; Parag, Capstick, & Poortinga, 2011). It is thought that a carbon price that is separate from the price of a product at the point of sale could be more salient to the consumer, which could lead to more considerable behavioural changes (Defra, 2008b, p. 8; Matthews, 2010, p. 478). In addition to reducing carbon emissions, PCT could have other advantages. In developed countries, obesity has reached epidemic proportions and is also becoming a serious problem in developing countries (World Health Organisation, 2017; World Obesity Federation, 2017). Egger (2008; 2011), one of the principal researchers of the larger project of which this research is part, has proposed that PCT could lead to a 'stealth' reduction in obesity and its underlying health issues. In conjunction with a secondary policy covering the business sector for those schemes that only cover household energy use, this would be achieved by promoting active transport (walking and cycling) over fossil fuel-powered transport and discouraging the consumption of energy-dense processed food products by increasing their price owing to their high carbon footprint.

Considerable research has been undertaken to assess the public acceptability of PCT (Low, 2005; Howell, 2007; Harwatt, 2008; Owen et al., 2008; Bird & Lockwood, 2009; Bristow et al., 2010, p. 1833; Jagers, Löfgren, & Stripple, 2010; Wallace et al., 2010). These studies show that PCT is usually the preferred carbon pricing policy (Fawcett, 2012, p. 286; Parag & Fawcett, 2014, p. 28) and may result in greater carbon reductions than comparable policies (Parag, Capstick, & Poortinga, 2011; Zanni, Bristow, & Wardman, 2013). At a political level, PCT has undergone a pre-feasibility study in the United Kingdom (Defra, 2008b; Fawcett, 2010b, pp. 6868-6869; Chamberlin, Maxey, & Hurth, 2014, p. 420) and has been examined in Ireland (Parag & Fawcett, 2014, p. 28). Yet, despite a broad body of literature about PCT, there does not appear to be any evidence outside of the current research of a PCTS or a PCMS having been implemented, trialled or assessed across a whole community.

1.3 The Originality of the Research

1.3.1 Trialling a PCMS

In the absence of any PCT trials, the research into the behavioural changes associated with PCT has been examined using simulations (Capstick & Lewis, 2010; Parag, Capstick, & Poortinga, 2011; Zanni, Bristow, & Wardman, 2013), or via small grassroots community-based groups voluntarily trying to live under self-imposed carbon budgets (Howell, 2012). To fully explore the case for PCT and increase interest in its implementation, several researchers have suggested that a voluntary PCT trial is required (Capstick & Lewis, 2010, p. 382; Fawcett, 2012, p. 289; Parag & Fawcett, 2014, p. 30; Guzman & Clapp, 2017, p. 623). The aforementioned NICHE project has been identified by Parag and Fawcett (2014, p. 30), Chamberlin et al. (2014, p. 421), and Guzman and Clapp (2017, pp. 620-621) as the first voluntary trial of its kind that assesses several significant aspects of a PCTS.

1.3.2 Predicting PCMS usage

From an information system and technology perspective, the literature shows that there are several well-established models that have been proposed to determine the usage, acceptance, and adoption of new technology (Davis, Bagozzi, & Warshaw, 1989; DeLone & McLean, 1992; Venkatesh & Davis, 2000; DeLone & McLean, 2002; Venkatesh & Bala, 2008, p. 278). The Extended Technology Acceptance Model

(Venkatesh & Davis, 2000), referred to as TAM2, was chosen from these models as the theoretical framework to underpin the research for this project. This decision was made as the constructs in TAM2 were deemed the most closely aligned with the current research, and the best fit for an information system like the NICHE PCMS (see Section 2.3.1). After reviewing the information systems literature, it became clear that the research conducted for this thesis is the first of its kind to use a technology acceptance model to examine the user acceptance and usage behaviour of a PCMS.

While TAM2 may provide a useful starting point to identify some of the factors that may predict the user acceptance and usage behaviour of a voluntary PCMS, TAM2 was designed for an information system implemented within a workplace setting (Venkatesh & Bala, 2008), rather than a public information system with an environmental outcome like a PCMS. Therefore, it is reasonable to assume that not all the constructs that predict the adoption of a traditional information system will be relevant in predicting PCMS user acceptance and usage behaviour. It is also reasonable to assume that other factors would influence PCMS usage, such as preconceived ideas about the causes of climate change, together with environmental attitudes and behaviours that are not relevant to the usage of traditional information systems.

The review of the literature found that understanding popular opinions and perceptions of climate change is critical to creating support for action on climate change, especially given the profound changes required for mitigation and adaptation (Capstick et al., 2015, p. 53; Poortinga et al., 2019, p. 25). The literature shows that climate scientists overwhelmingly agree with the science behind anthropogenic climate change (Anderegg et al., 2010, p. 12108; Cook et al., 2013, p. 1; Powell, 2015, p. 121). Yet many members of the general public remain sceptical about the degree to which humans are contributing to climate change, with some contending that climate change is mainly or indeed entirely the result of natural processes (Leviston, Greenhill, & Walker, 2015, p. 8; Funk & Kennedy, 2016, p. 22; Funk & Hefferon, 2019, pp. 7-8). While extensive research has been conducted into public perceptions of climate change and climate change scepticism (Capstick et al., 2015), no research was found looking at how climate change scepticism would influence voluntary PCMS usage.

Webb (2018, p. 138) identified the need to "explore attitudes, which can predict the public acceptability of PCT and how these might be leveraged to garner public support for the implementation of PCT". As an extension to their research, Capstick and Lewis (2010, p. 382) recommended that future research should examine PCT according to environmental attitudes. The literature shows that most people care about the environment, yet these concerns do not always translate into behaviours (Funk & Kennedy, 2016, p. 17; European Commission, 2017, p. 16; Planet Ark, 2018, p. 11). The difference between attitudes and behaviours, known as the 'value-action gap' (Godin, Conner, & Sheeran, 2005), is particularly prevalent in environmental policy (Blake, 1999; Flynn, Bellaby, & Ricci, 2009, p. 159). The literature also shows that environmental behaviours are often undertaken for financial reasons (Whitmarsh, 2009; Leviston et al., 2013, p. 9), ethical/lifestyle reasons (Shaw & Newholm, 2002; Radnitz, Beezhold, & DiMatteo, 2015, p. 32), or health reasons (Passafaro et al., 2014, p. 77; Radnitz, Beezhold, & DiMatteo, 2015, p. 31) that have little to do with environmental concerns. There is evidence that individuals who are concerned about the environment are more likely to engage in community-related environmental behaviours (Leviston, Greenhill, & Walker, 2015, p. 19) and support the introduction of a PCT (Capstick & Lewis, 2010, p. 382). Research conducted by the author before the NICHE PCMS trial (see Section 1.5.1) found that an individual's attitudes towards their carbon footprint, the environment and climate change were significant predictors of their attitudes towards PCT (Hendry, 2014; Hendry et al., 2015). No literature, however, was found regarding how an individual's environmental attitudes and behaviours would predict actual voluntary usage of a real-world PCMS.

One of the broader objectives of the NICHE project is to examine the link between PCT and health. The literature shows that there is a relationship between health and obesity (U.S. Department of Health and Human Services, 2013), and increased carbon emissions (Egger & Swinburn, 2011). The candidate's research before the NICHE PCMS trial (see Section 1.5.1) showed that an individual's evaluation of their health and their attitudes towards health and body weight were significant predictors of their attitudes towards PCT (Hendry, 2014; Hendry et al., 2015). The review of the literature did not identify any other studies that explore the direct relationship between health, body weight and PCT, and no literature was found dealing collectively with health, body weight, and usage of a system like the NICHE PCMS.

The research presented in this thesis is intended to bridge the gaps that were identified in the review of the literature and are summarised in this section. After thoroughly reviewing the available literature, it was determined that the research presented herein represents the first study of its kind to:

- Trial a voluntary PCMS across a whole community;
- Identify the changes in attitudes and behaviours resulting from a voluntary PCMS trial and how these attitudes and behaviours predict attitudes towards PCT;
- Identify how an individual's anthropogenic climate change beliefs predict voluntary PCMS usage;
- Identify how an individual's environmental attitudes and behaviours predict voluntary PCMS usage;
- Identify how an individual's self-reported health and attitudes towards health and body weight predict voluntary PCMS usage;
- Identify the differences in attitudes and behaviours between those who would voluntarily use a PCMS and those who would not; and
- Apply a technology acceptance model (TAM2) to a PCMS.

Identifying the changes in attitudes and behaviours resulting from the NICHE PCMS trial will provide a basis to assess whether a PCMS is a viable option to mitigate household carbon emissions and should be included in future carbon emission reduction efforts. The differences in the attitudes and behaviours of those who would participate in a voluntary PCMS trial, and those who would not, is highly relevant for researchers, community groups, and lobbyists seeking to understand how a PCMS would be accepted in a larger population sample and could be leveraged to identify suitable communication strategies with the aim of improving the public acceptability of systems that aim to monitor an individual's carbon emissions. As there have been several alternatives put forward to limit carbon emissions, the research conducted in this thesis will provide a starting point for evaluating whether a PCMS is the best option for those looking to influence legislation or change government policy as it pertains to national carbon emission budgets. In addition, the research aims to provide a validated model as a basis for future research into PCMS usage. Given that the PCMS trialled for the research was developed based upon the most well-developed conceptual PCT schemes and represented several significant aspects of a PCTS (see Section 1.4.2), such a model could be used as a starting point to help predict the public acceptability and usage of the proposed PCT schemes and ascertain the degree of public support – or otherwise – for the implementation of PCT.

1.4 The NICHE Project

The broader objectives of the NICHE project were to trial a voluntary PCTS and investigate its public acceptability, together with its effect on health, carbon emissions, and the environment. The study was conducted by researchers from the Southern Cross University School of Business and Tourism and the School of Health and Human Sciences and was supported by a linkage grant from the Australian Research Council (ARC). Given the multidisciplinary nature of the NICHE project, the following research aims were identified when the project was established:

- Researchers from the School of Health and Human Sciences would explore whether PCT is effective in reducing an individual's carbon footprint and their body weight; and
- Researchers from the School of Business and Tourism would investigate PCT usage and acceptability.

1.4.1 Norfolk Island

At the commencement of the NICHE project, a small community was sought that met the following criteria:

- A closed island system where energy consumption, transportation, and all inputs and outputs could be easily measured;
- Demographically, economically, and culturally similar to Australia; and
- Support of the local Government and community;

Norfolk Island is a small island (5 by 8 km) in the Pacific Ocean located 1,412 kilometres directly east of Evans Head on the east coast of New South Wales, Australia (see Figure 1-1 below).

Figure 1-1 Location of Norfolk Island
Map data: Google maps

Norfolk Island was uninhabited when it was landed upon and named by the British explorer Captain James Cook in 1774. When Great Britain settled Australia in 1788, Norfolk Island was used as a penal colony until its abandonment in 1855. The permanent civilian residence of Norfolk Island began in 1856 when the descendants of the *HMS Bounty* mutineers were relocated from Pitcairn Island. In 1914 Norfolk Island was handed over to Australia to administer as an external territory. The resident population of Norfolk Island as reported in the 2016 Australian census was 1,748 (Australian Bureau of Statistics, 2016b), one-third of whom are descendants of those relocated from Pitcairn Island, with the remainder mostly coming from Australia and New Zealand in the intervening years (Webb, 2018). Culturally and demographically, Norfolk Island is very similar to the Australian mainland (Hendry, 2014).

Several other island communities, including Mauritius, Thursday Island, and Vanuatu were considered but were discounted based on their levels of carbon emissions, obesity, economic development, or cultural dissimilarity to the Australian mainland. After further consideration of the possibilities, Norfolk Island was selected for further investigation as a study site as it met with the above criteria. In late 2009, the Norfolk Island Legislative Assembly (NIA) was approached to run a PCT trial on the island. Throughout 2010, discussions with relevant stakeholders and community groups were held on the island and in late 2010 a formal presentation of the project and proposed system was made and subsequently accepted by the NIA. At this time, the name NICHE (Norfolk Island Carbon and Health Evaluation) was chosen for the project. The choice of Norfolk Island and the establishment of the NICHE PCMS trial are covered further in Section 3.2.1.

1.4.2 The NICHE PCMS

The NICHE Personal Carbon Monitoring System (PCMS) was designed and programmed by the author of this thesis based upon the most well-developed conceptual downstream PCT schemes identified in the review of the PCT literature (see Section 2.2.4.1). From March 2013 until July 2014, the NICHE PCMS monitored the carbon emissions from the fossil fuel usage (petrol, diesel, electricity and gas) of 219 households on Norfolk Island that volunteered to participate in the NICHE PCMS trial. Owing to the lack of support from the banking sector in using their infrastructure, it was not possible to implement the tradable carbon allowances provided in all the proposed PCT schemes. In place of carbon allowances, each household was assigned a non-compulsory carbon emission reduction target, based on the number of occupants in the household, after six months of baseline emissions data collection. Participating households could monitor their carbon emissions online or via quarterly paper-based carbon statements. The NICHE PCMS trial resulted in an 18.0% reduction in total household carbon emissions (Webb, 2018, p. 116). The NICHE PCMS and the carbon reduction target are described in detail in Sections 3.2.2 to 3.2.4.

1.5 Summary of the Data Collection

The data collection for the research is summarised in this section. A baseline survey of households on Norfolk Island was undertaken before the commencement of the NICHE PCMS trial (referred to as the **pre-PCMS survey** in this thesis). Data analysis was undertaken on the pre-PCMS survey and reported in the candidate's Master of Business thesis entitled "Factors affecting the intention to use a personal carbon trading system" (Hendry, 2014). In the chapters that follow, the research undertaken on the pre-PCMS survey dataset for the candidate's Master of Business is referred to as the **pre-PCMS analysis**. An overview of the pre-PCMS survey and the pre-PCMS analysis is provided in the next section.

The survey was repeated following the NICHE PCMS trial (referred to as the **post-PCMS survey** in this thesis). While additional analysis was undertaken on the pre-PCMS survey dataset, primarily in the form of Mann Whitney U tests to compare responses between surveys, the PhD research reported in this dissertation is based on the data analysis conducted on the post-PCMS survey dataset. In the chapters that follow, this data analysis is referred to as the **post-PCMS analysis**. An overview of the post-PCMS survey is provided in Section 1.5.2 of this chapter.

1.5.1 Pre-PCMS Survey

The pre-PCMS survey was administered in mid-2012 before the commencement of the NICHE PCMS trial and was available to all households on Norfolk Island. A copy of the pre-PCMS survey is included in Appendix B. The purpose of the pre-PCMS survey was to gather preliminary data on individual and household attitudes and behaviours across a range of areas, including PCT in order to evaluate the impact of the NICHE PCMS trial.

As part of the pre-PCMS analysis, exploratory factor analysis (EFA) was conducted on the survey items that were included in the pre-PCMS survey as measures of attitudes towards PCTS, resulting in a single factor that was labelled *Usage Intentions towards a PCTS*. The EFA conducted on the remaining survey items in the pre-PCMS survey that were relevant to the research identified the following five factors that are listed below with their definitions:

- *Self-Health Evaluation* – An individual's evaluation of their health;
- *Health Consciousness* – An individual's attitudes towards health and body weight;

- *Environmental Action* – An individual's environmental and consumption behaviours;
- *Environmental Consciousness* – An individual's attitudes towards their carbon footprint, the environment and climate change; and
- *Optimism* – An individual's attitudes towards the perceived impact that technology could have in relation to improving health and environmental change.

These factors were entered as blocks of variables into a regression model that showed that an individual's *Usage Intentions towards a PCTS* was predicted by *Self-Health Evaluation*, *Health Consciousness*, *Environmental Consciousness,* and *Optimism*. *Environmental Action* was not found to be a significant predictor of *Usage Intentions towards a PCTS*.

The pre-PCMS analysis conducted for the candidate's Master of Business provided valuable insight into the factors that would affect an individual's intention to use a PCTS. However, as it was based on the pre-PCMS survey that was conducted to gather preliminary data *before* the roll-out of the NICHE PCMS, it contained the following limitations:

- It measured attitudes towards a generic, hypothetical PCTS rather than a real-world PCT-like system;
- The survey respondents had a limited awareness of their actual carbon footprint; and

- The survey respondents answered questions based upon their preconceived views surrounding PCT as they had had no practical experience using such a system.

Given that the literature surrounding PCT is theoretical and there are no examples of a PCTS or a PCMS having been implemented outside of the current research, the limitations discussed above are not unique to the pre-PCMS analysis and are contained in all the PCT research to date that was reviewed. The results of the pre-PCMS analysis are discussed further in Section 2.4.

1.5.2 Post-PCMS Survey

The post-PCMS survey was administered in October 2014 after the NICHE PCMS trial concluded. A copy of this survey is included in Appendix C. The NICHE PCMS is referred to as the NICHE Carbon Card System in the post-PCMS survey or alternatively the NICHE PCTS in some publications by the author or other NICHE researchers (Webb & Egger, 2013; Hendry, 2014; Webb et al., 2014; Hendry et al., 2015; Hendry et al., 2016; Webb, 2018). To allow a comparison of the attitudes towards PCTS between those who would voluntarily use a system like the NICHE PCMS, and those who would not, all households on Norfolk Island were invited to participate in the post-PCMS survey. The post-PCMS survey contained Survey Item F10 (*Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?*) to differentiate between them. In the following sections of the thesis, post-PCMS survey respondents who participated in the NICHE PCMS trial are referred to as **PCMS users**. Those that did not participate in the NICHE PCMS trial are referred to as **non-PCMS users**. An additional section was included in the post-PCMS survey to gather data from PCMS users specific to technology acceptance and the usage of the NICHE PCMS. The post-PCMS survey measured attitudes towards a real system based upon the most well-developed conceptual PCT schemes that included several significant aspects of a PCTS. Households that participated in the NICHE PCMS trial had experience using the system, together with a greater awareness of their carbon footprint. Therefore, the research reported in this thesis addresses some of the limitations identified in the pre-PCMS analysis and the PCT literature.

1.6 Research Questions and the Conceptual Model

Based on the gaps in the knowledge identified in the review of the literature, and the aims of the research listed in Section 1.1 of this chapter, the following research questions that could be empirically examined were developed:

1. What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?
2. What differences in attitudes towards PCTS will be evident between those who volunteered for the NICHE PCMS trial and those who did not?
3. What factors influenced the usage behaviour of the NICHE PCMS?

To examine the third research question, a conceptual model was developed by modifying and extending TAM2 with additional constructs identified in the literature and the pre-PCMS analysis. The construction of the proposed conceptual model is discussed in Section 3.3.4.4.

1.7 Limitations of the Research

There are several limitations of the research that could limit whether the findings could be generalised to inform our understanding of the possible attitudes towards PCTS or PCMS in other populations and other countries. The limitations identified at the start of the NICHE PCMS trial are discussed below, while those identified as the project progressed are discussed in Section 7.4 of the concluding chapter.

Norfolk Island was ideal for this study, although it has some limitations. While its population is reasonably representative of other developed locations, it is realistic to assume that the residents of Norfolk Island are more resource-conscious than residents of the Australian mainland. Given the geographic isolation and small size of Norfolk Island, the residents could be expected to be connected more closely to their resources. For example, they see where their water comes from and where their waste goes. They are aware that most of their resources, including all fossil fuels and most of their food products, must be shipped to the island, while the island's power plant runs on diesel to generate electricity. This means that these items are more expensive than they are in mainland Australia. At A$0.62 per kilowatt-hour (kWh), electricity prices were more than twice the Australian average (Department of Infrastructure, 2015). Throughout the NICHE trial, petrol and diesel prices were always around A$2.50, well above an average of A$1.56 in mainland Australian cities at the time (Australian Competition and Consumer Commission, 2014). As a result, a more substantial proportion of households have solar power and solar hot water compared to mainland Australia. In the 2011 Census on Norfolk Island, 49% of homes reported having solar panels for energy or hot water (Taylor & McNiel, 2011). In comparison, only 15% of households in Australia had solar panels for energy or hot water in 2015 (Australian Bureau of Statistics, 2017). Further, the median weekly household income on Norfolk Island of A$1,012 as reported in the 2016 Australian census (Australian Bureau of Statistics, 2016b), was considerably less than the A$1,438 median weekly household income reported for Australia as a whole (Australian Bureau of Statistics, 2016a).

In accord with the above considerations, it is reasonable to expect that many residents of Norfolk Island would be more aware of their consumption habits, which will ultimately affect their carbon footprint – and indeed their general cost of living, which may already have resulted in a higher degree of parsimony with regard to energy consumption compared to other populations. The subtropical climate of Norfolk Island must also be considered. Average maximum temperatures range between 18°C and 19°C in winter and between 23°C and 25°C in summer. Average minimum temperatures range between 13°C and 15°C in the winter and between 18°C and 20°C in the summer (Australian Bureau of Meteorology, 2019). As a result, there is not a great demand for energy-intensive heating or cooling (see Section 3.2.4). Therefore, while the results of the research are comprehensive, the extrapolation of the findings to the general population of, for example, mainland Australia needs to be undertaken cautiously.

The pre-PCMS survey measured attitudes towards a theoretical PCTS, and participants had no experience with such a system. The post-PCMS survey measured attitudes towards the NICHE PCMS. While the NICHE PCMS was based upon the most well-developed conceptual downstream PCT schemes and provided feedback on carbon emissions and a carbon reduction target, there was no trading aspect or financial penalties or incentives for carbon emissions. This difference could have led to some of the differences in attitudes and behaviours identified in the pre-PCMS and post-PCMS surveys that are discussed in Chapters Four and Five. The potential limitations owing to the lack of trading are discussed further in Section 7.4.

Another limitation of the study is that, while the NICHE PCMS tracked the carbon emissions of a whole household, the surveys were completed by one member of each household. As a result, the attitudinal items in the surveys reflect that particular person's views and are not necessarily the views of *all* members of the household. However, as will be demonstrated in Section 4.2, the survey respondents are representative of the broader Norfolk Island population, so the survey responses, it follows, could be regarded as being representative of the views of the broader population of Norfolk Island.

It also needs to be recognised that the views of non-respondents could differ somewhat to that of the respondents on account of self-selection bias. Self-selection bias is a common problem when survey respondents decide for themselves whether to participate in a survey (Lavrakas, 2008). Individuals may not respond to a survey because of overall disinterest in the subject matter, their broader political views, low literacy levels, or concerns about privacy and confidentiality. This particular limitation, however, is not unique to this study and affects all research.

Finally, the unique nature of the research makes it difficult to identify similar studies for comparative purposes. This lack of comparative research in the literature means that the conceptual model and the constructs are tested for the first time in this study.

1.8 Organisation of the Thesis

This thesis is comprised of six chapters, which are organised as follows:

Chapter 1 – Introduction

This chapter introduced the research. The chapter started with an overview of the research, the background, and its originality. The NICHE project, the choice of Norfolk Island, and the NICHE PCMS were described, followed by a summary of the data collection, and the research questions. The limitations of the research were then discussed.

Chapter 2 – Literature Review

Chapter 2 summarises the literature that is relevant to the research and contains three components. The first component describes the literature that is relevant to the background of the research and PCT. The second component provides an overview of the literature that was reviewed to identify possible factors that may predict voluntary usage of the NICHE PCMS. The third component discusses the research conducted to date as a part of the NICHE project that resulted in the author's Master of Business and other publications.

Chapter 3 – Methodology

Chapter 3 details the methodology used for the research. The establishment, objectives, stakeholders, and initial stages of the project are described, followed by the design, development, promotion, and administration of the NICHE PCMS. The empirical strategy of the research, including an overview of the pre-PCMS and post-PCMS surveys, administration practices, promotional activities, and sample selection is discussed. The construction of the proposed conceptual model and the post-PCMS survey is detailed. The chapter concludes with a description of the statistical analysis procedures that are used for the post-PCMS data analysis.

Chapter 4 – Descriptive Analysis

Chapter 4 compares key demographic data from a) the pre-PCMS and post-PCMS surveys to the 2011 and 2016 censuses that were conducted on Norfolk Island and b) the post-PCMS survey for PCMS users and non-PCMS users. A selection of survey items measuring attitudes toward the environment, carbon emissions, climate change, health and PCTS are compared from a) the pre-PCMS and post-PCMS surveys, and b) the post-PCMS survey for PCMS users and non-PCMS users to identify any significant differences. Finally, the responses to the post-PCMS survey items that were included as measures of the usage behaviour of the NICHE PCMS are examined.

Chapter 5 – Data Analysis

Chapter 5 describes the statistical analysis undertaken on the post-PCMS survey to examine the three research questions. The chapter starts by detailing the data preparation that was undertaken on the post-PCMS survey. The correlation analysis and exploratory factor analysis that was conducted on the post-PCMS survey is then discussed. The chapter concludes with a description and discussion of the post-PCMS regression analysis.

Chapter 6 – Discussion

Chapter 6 discusses the research outcomes for the three research questions that were identified in Chapter 1. Findings from the research related to the broader objectives of the NICHE project and the additional key findings that were identified during the investigation are described, and recommendations for future PCMS/PCTS projects are made.

Chapter 7 – Conclusion

Chapter 7 summarises the outcomes of the research. The significance of the research and the limitations of the research that were uncovered during the investigation are described. The chapter concludes with recommendations for future research and final remarks.

Chapter 2 - Literature Review

2.1 Introduction

This chapter summarises the literature that is relevant to the research conducted in this thesis. The review of the literature contains the following three sections:

- 2.2 Mitigating Climate Change;
- 2.3 Measuring PCMS Usage; and
- 2.4 Pre-PCMS Analysis.

Understanding PCT and where it fits into current efforts to mitigate anthropogenic climate change is fundamental to the research covered in this thesis. Section 2.2 describes the background for the research, including an overview of climate change, carbon pricing, and the carbon reduction initiatives implemented to date, followed by a review of the PCT literature. Section 2.3 summarises the literature that was reviewed to identify the possible attitudes and behaviours that would influence an individual to participate in a voluntary PCMS trial, and how best to measure PCMS usage and acceptance. An overview of the technology acceptance literature is provided. The research covering the general public's beliefs about climate change, the differences between environmental attitudes and behaviours, and possible links with PCMS usage are described. The literature exploring the relationship between health, obesity, carbon emissions, and PCMS usage is then discussed. Section 2.4 describes the data analysis that was undertaken on the pre-PCMS survey and reported in the candidate's Master of Business thesis and other publications by the author or that the author contributed towards (Hendry, 2014; Webb et al., 2014; Hendry et al., 2015; Hendry et al., 2016). The chapter concludes with a summary of the literature and the gaps in the knowledge that the research in this thesis aims to explore.

2.2 Mitigating Climate Change

2.2.1 Carbon Emissions and Climate Change

When solar radiation strikes the surface of our planet, part of it is reflected upwards into the atmosphere. Greenhouse gases (GHGs) in the atmosphere absorb some of this reflected radiation and re-emit it, and the remainder is radiated back into space (U.S. Environmental Protection Agency, 2016; NASA, 2017a). Radiative forcing (RF) is the difference between the energy absorbed by the atmosphere and the energy radiated back into space. The proportion of GHGs in the atmosphere can change the balance between the incoming and outgoing energy the earth receives from the sun, increasing the RF, and leading to warming (IPCC, 2014a, p. 1269; U.S. Environmental Protection Agency, 2016, p. 3).

Since the industrial revolution, human activity has resulted in the emission of increasing amounts of GHGs into the atmosphere, in particular, carbon dioxide, methane and nitrous oxide. This has led to significant changes in the climate including global warming, increased precipitation and flooding, more severe cyclones, more severe droughts, a rise in sea temperatures and ocean acidity, increased sea levels, decreased sea ice and glaciers, and declining snowfall in some areas (IPCC, 2014a, 2014b; U.S. Environmental Protection Agency, 2016; NASA, 2017b).

While all GHGs play a role in climate change, anthropogenic climate change is primarily caused by carbon dioxide (IPCC, 2013, 2018). Carbon dioxide accounts for three-quarters of total GHG emissions and, once released, can stay in the atmosphere for thousands of years until it is absorbed by the earth's carbon sinks (U.S. Environmental Protection Agency, 2016, p. 14). In comparison, methane has an average lifespan of 12.4 years, while nitrous oxide has an average lifespan of 121 years (U.S. Environmental Protection Agency, 2016, p. 6). In addition to having the most extended atmospheric lifespan, carbon dioxide accounts for the largest share of RF of any of the GHGs (IPCC, 2014a; U.S. Environmental Protection Agency, 2016, p. 16). The increase in carbon dioxide in the atmosphere is primarily due to the burning of fossil fuels and secondarily from the loss of forests cleared predominantly for agricultural use (IPCC, 2013, p. 11).

2.2.2 Carbon Pricing

In order to mitigate anthropogenic climate change, it is widely agreed that carbon emissions must be limited (IPCC, 2014b, p. 98). Metcalf (2019b, pp. 5-6) describes carbon emissions as a negative externality, where the price of the product does not reflect the actual cost of the product. The standard economic solution for a negative externality is a Pigouvian tax that involves a price equal to the social value being placed on the negative externality to correct the market failure (Metcalf, 2019b, pp. 5-

6). It is widely agreed that a carbon price is the most effective way for a country to reduce carbon emissions (IPCC, 2018, p. 152; London School of Economics and Political Science, 2018). Carbon prices are intended to encourage a reduction in the amount of carbon emitted into the atmosphere by incentivising investment, research, the usage of alternative forms of energy, and to reduce future abatement costs (High-Level Commission on Carbon Prices, 2017).

The Paris Agreement, negotiated by nearly 200 countries at the 21st conference of the United Nations Framework Convention on Climate Change (UNFCCC), has set the goal of limiting global warming to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C (Phillips, 2015; Burger & Wentz, 2017). The High-Level Commission on Carbon Prices has concluded that, in order to achieve the Paris Agreement's temperature target, a carbon price of at least US$40–80 per tonne by 2020 and US$50–100 per tonne by 2030 is required, provided that suitable government policies are in place (High-Level Commission on Carbon Prices, 2017). The carbon prices in the "Global Warming of 1.5°C" report, released in October 2018 by the Intergovernmental Panel on Climate Change (IPCC), has ranges of US$135–6,050 per tonne in 2030 and US$245–14,300 per tonne in 2050. The price differences depend on whether the temperature is limited to 1.5°C or 2°C, and whether other factors like large land-use carbon sinks are also considered (IPCC, 2018, p. 152).

2.2.3 Carbon Taxation vs Cap and Trade

2.2.3.1 Theory

The two main proposals to establish a carbon price, a carbon tax and cap-and-trade, were defined in Section 1.2 of the introductory chapter. While there is widespread agreement about the advantages of a carbon price in reducing carbon emissions, there is much debate whether a carbon tax or a cap-and-trade system is the better policy option (Yale School for Forestry and Environmental Studies, 2009; Goulder & Schein, 2013, pp. 1-2; Carl & Fedor, 2016, p. 50). The advantage of a carbon tax is that the carbon price is known in advance, thereby allowing for forward planning and stability for businesses, investors, and consumers, although there is no guarantee in hitting a reduction target. In contrast, cap-and-trade sets a clear reduction target that can be planned and implemented over time, but the market sets the carbon price, making it hard to predict (Weitzman, 2015, p. 3; High-Level Commission on Carbon Prices, 2017, p. 10). Both options can be modified to mitigate their uncertainties. If a carbon tax underperforms from an environmental perspective, it can be raised (Aldy, 2017). To increase the pricing predictability of cap-and-trade, a hybrid system can be developed that sets a floor and ceiling price for permits, and permits can be banked and borrowed over time (Goulder & Schein, 2013, p. 3; High-Level Commission on Carbon Prices, 2017).

Some regard carbon taxes as the simpler option to implement and administer as they can be built upon already existing taxation systems, no market trading system is required, and rules do not need to be enforced (Weitzman, 2015; High-Level Commission on Carbon Prices, 2017; Metcalf, 2019b, pp. 7-8). Others disagree, claiming that governments do not write simple tax bills and any tax legislation will be complex (Yale School for Forestry and Environmental Studies, 2009). In practice, the evidence does not always support the argument for carbon tax simplicity (Carl & Fedor, 2016, p. 53) and the efficiency of carbon taxation and cap-and-trade depends on underlying modelling assumptions (Metcalf, 2019b, p. 7). Carbon taxes have been criticised for allowing industry the opportunity to lobby for exemptions, while similar criticisms have been made against cap-and-trade and the concept of “grandfathering”, where existing polluters are allocated free permits (Smith, 2008; The World Bank, 2009). One final difference between a carbon tax and cap-and-trade is revenue production. Carbon taxes are designed to raise revenue from their introduction, and are often justified as much for their ability to raise revenue, provide rebates, and offset reliance on other forms of taxation, as their ability to mitigate carbon emissions (Sumner, Bird, & Dobos, 2011, pp. 5-6; Carl & Fedor, 2016, p. 53; Partnership for Market Readiness, 2017a, pp. 27-28). The revenue raised by carbon taxes and cap-and-trade is discussed further in Section 2.2.3.3 of this chapter.

2.2.3.2 Upstream vs Downstream Regulation

For both carbon pricing initiatives, the point of regulation can occur either upstream, midstream, or downstream (Mansur, 2011). As regulation moves down the supply chain, the number of entities that need monitoring increases. Upstream regulation at fewer than 3,000 points could capture approximately 80% of U.S. emissions, as opposed to downstream regulation where potentially millions of pollution sources would need to be monitored (Metcalf & Weisbach, 2009, p. 501). As a result, upstream regulation has less scope for evasion (Matthews, 2010, p. 478), and generally requires less time to develop than downstream regulation, which requires additional capacities for monitoring, reporting and verification (MRV), thus making it harder to administer (Partnership for Market Readiness, 2017a, p. 10). The differences in the number of producers and importers upstream, and the number of consumers downstream, also results in lower MRV costs in upstream regulation (Mansur, 2011, pp. 184-185; Goulder & Schein, 2013, pp. 11-12; Partnership for Market Readiness, 2017a). The transaction costs faced by smaller emitters can also be disproportionately high in a downstream scheme, when compared with the costs for larger emitters, which is not such an issue when regulation occurs upstream (Coria & Jaraitė, 2019, p. 966).

However, upstream regulation can result in carbon leakage. Carbon leakage refers to an increase in emissions in an unregulated section of the economy, as a result of reductions in a regulated section of the economy, owing to the differences in price. Carbon leakage becomes less of an issue as regulation moves downstream through the supply chain, and the price increases are closer to the consumer (Bushnell & Mansur, 2011; Mansur, 2011, p. 184). It is also argued that upstream regulation puts producers at a competitive disadvantage compared to unregulated competitors (Goulder & Schein, 2013, p. 9), and does not offer the opportunity to for companies to choose downstream options to reduce emissions without further incentives (Metcalf & Weisbach, 2009, p. 501; Mansur, 2011, p. 192).

2.2.3.3 Practical Implementations

Figure 2-1 below shows the multinational, national, and sub-national carbon tax and cap-and-trade initiatives that have been implemented, or planned for implementation, and the share of global emissions covered by each of the initiatives as of the 1st of April 2019.

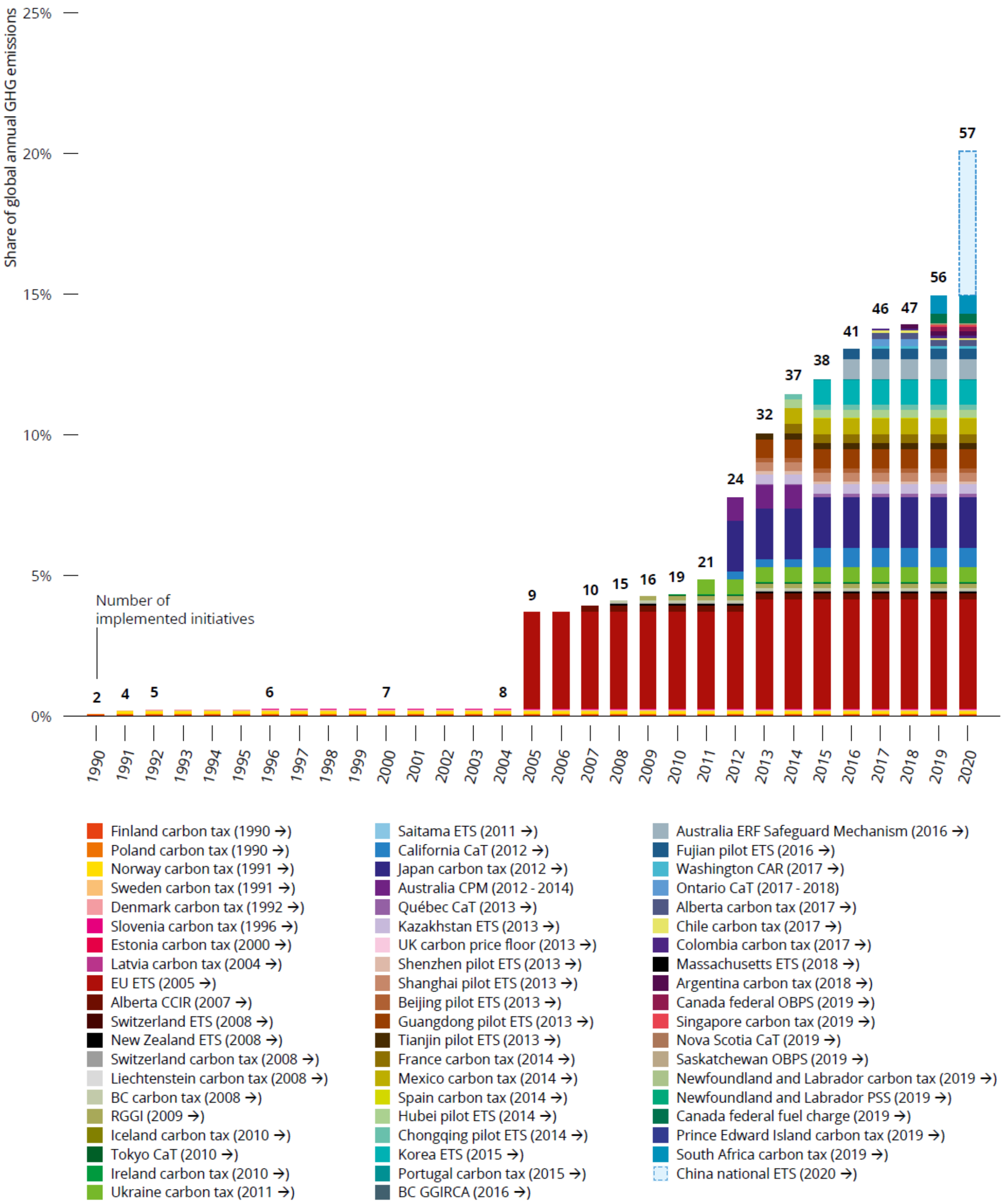

Figure 2-1 Carbon Pricing Initiatives and the Share of Global Emissions Covered (World Bank, 2019, p. 25). Reprinted with permission.

As Figure 2-1 above shows, the first carbon tax was introduced in Finland in 1990, and carbon taxes were initially more popular than cap-and-trade. Eight countries introduced carbon taxes before the first cap-and-trade system, the EU ETS, was introduced in 2005. However, as of April 2019, the figures are almost identical, with 28 cap-and-trade and 29 carbon tax initiatives having been implemented, or scheduled for implementation, at a multinational, national, or sub-national level. The EU ETS covers the largest share of global emissions of any carbon pricing initiative (High-Level Commission on Carbon Prices, 2017; World Bank, 2019, p. 25) and the largest geographic area (European Commission, 2015). The only other carbon pricing initiative that operates across national borders is the partnership between the Quebec CaT (cap-and-trade) and the California CaT. Quebec and California formally linked their systems on the 1st of January 2014, thereby allowing businesses in one jurisdiction to use permits issued by the other for compliance (Center for Climate and Energy Solutions, 2017). The Japanese carbon tax covers the largest share of global emissions of any of the taxes (World Bank, 2019, p. 25).

At a jurisdictional level, the Quebec CaT, the California CaT, and the Nova Scotia CaT cover the largest share of emissions of any of the carbon pricing initiatives (80–85%) (World Bank, 2019, p. 28). Of the carbon taxes, the South African carbon tax (75%) covers the largest share of emissions at a jurisdictional level (Partnership for Market Readiness, 2017a, p. 77). Other carbon pricing initiatives covering more than 50% of emissions in their jurisdiction include the Korea ETS (70%), Japan carbon tax (70%), British Columbia carbon tax (70%), Ukraine carbon tax (70%), Fujian pilot ETS (60%), Guangdong pilot ETS (60%), Norway carbon tax (60%), Shanghai pilot

ETS (57%), Tianjin pilot ETS (55%), and the New Zealand ETS (51%). The remaining 43 carbon pricing initiatives all cover less than 50% of emissions in their respective jurisdictions due to exemptions in the market for producers and industries, or, in the case of the EU ETS and carbon taxes in European countries, overlapping carbon pricing initiatives (Partnership for Market Readiness, 2017a, pp. 76-77; 2017b; International Carbon Action Partnership, 2019; World Bank, 2019).

The carbon prices under the carbon tax initiatives range from less than US$1 a tonne in Poland and Ukraine, up to US$127 a tonne in Sweden, while under cap-and-trade, carbon prices range from US$1 a tonne for the Chongqing and Shenzhen pilot ETS's, up to US$25 a tonne for the EU ETS (World Bank, 2019, p. 21). Analysis by Carl (2016) on carbon revenue spending for 40 countries and 16 states or provinces found that carbon taxes raised three times more money than cap-and-trade, and the revenue accounted for a higher percentage of GDP (0.13% for taxes as opposed to 0.02% for cap-and-trade); however, 44% of the revenue from carbon taxes was returned to taxpayers through tax cuts and rebates, with a further 28% used to supplement government funds, whereas 70% of the revenue raised under cap-and-trade was used for "green" spending (Carl & Fedor, 2016).

Most of the carbon tax initiatives are applied upstream on producers and importers, and midstream on generators and distributors. Exceptions include the South Africa carbon tax, where industrial facilities are also taxed, and British Columbia, where a carbon tax on the sale of fuels is paid downstream but collected upstream (Partnership for Market Readiness, 2017a, pp. 76-77). In contrast, most of the cap-and-trade systems are regulated downstream. The exceptions are the New Zealand ETS, where the point of regulation is generally placed upstream, and the Québec CaT, Nova Scotia CaT, and California CaT, where the point of regulation is a mixture of upstream and downstream (International Carbon Action Partnership, 2019). The number of entities each of the cap-and-trade systems regulates downstream is dependent on the sectors targeted, and the inclusion threshold of the system. For example, the International Carbon Action Partnership (2019) reports that the largest of the cap-and-trade systems, the EU ETS, covers more than 11,000 entities with a rated thermal input exceeding 20 Megawatts (MW). The second largest, the Korea ETS, covers approximately 610 entities. The inclusion threshold is a company that emits more than 125,000 tonnes of carbon dioxide a year (tCO_2/year) or a facility that emits more than 25,000 tCO_2/year. The third-largest, the Guangdong pilot ETS, covers approximately 290 entities that emit more than 20,000 tCO_2/year, or consume more than 10,000 tonnes of coal equivalent a year (International Carbon Action Partnership, 2019).

2.2.4 Personal Carbon Trading

2.2.4.1 Proposed PCT Schemes

In Section 1.2 of the introductory chapter, PCT was discussed as one of the main proposals put forward to limit the approximately 40% of direct carbon emissions (Parag & Fawcett, 2014) produced by households, some of which are exempt from regulation under the current cap-and-trade schemes in operation. The notion of tradable personal allowances was first proposed by Barret (1995) as a response to traffic pollution. Soon after, Fleming (1997a, 1997b) proposed the concept of Domestic Tradable Quotas (DTQs) to mitigate carbon emissions for the United Kingdom economy. Under Fleming's plan, a ten-year carbon budget is established and divided into quotas. On an equal per capita basis, 45% of the quotas are distributed to all adults for free, while the remaining 55% are sold in a carbon market to other sectors in the economy. The quotas for fuel purchases are transferred from buyers to sellers electronically. Low carbon emitters can sell their unused quotas on the carbon market, whereas high carbon emitters are required to buy additional quotas. Fleming argued that such a system is progressive, thus providing a positive incentive for poorer households, and a negative incentive for wealthier households (Fleming, 1997a, 1997b).

Several other variations on PCT followed, covering different parts of the economy. These proposals include:

- Tradable Consumption Quotas (Ayres, 1997) and Tradable Energy Quotas (TEQs) (Fleming, 2005) in the United Kingdom, and Cap and Share (C&S) (The Foundation for the Economics of Sustainability, 2008) in Ireland, which cover the whole economy;
- Personal Carbon Allowances (PCA) (Hillman, 1998; Fawcett, 2004; Hillman & Fawcett, 2004; Fawcett et al., 2007) in the United Kingdom, and the

Carbon, Health and Savings System (CHSS) (Guzman & Clapp, 2017) in British Columbia, which cover household energy and personal transport;

- Household Carbon Trading (HHCT) (Niemeier et al., 2008) in California, which covers household electricity and gas; and
- Tradable Transport Carbon Permits (Raux & Marlot, 2005; Harwatt, 2008) in France and the United Kingdom, which cover private road transport.

Some of the proposals are merely outlines (HHCT, Tradable Consumption Quotas), while others are well detailed and developed (TEQs, PCAs, and C&S); however, all of the PCT schemes listed above have the following recommendations as the basis for their proposal (Roberts & Thumim, 2006, p. 4; Parag & Eyre, 2010, p. 354; Fawcett & Parag, 2010a, p. 332; Fawcett, 2012, p. 283):

- The schemes are mandatory;
- Individuals periodically receive a carbon allowance;
- Allowances are surrendered for carbon emissions;
- Allowances are tradable to meet the requirements of above-average and below-average carbon emitters; and
- Allowances contract over time to drive emission reductions.

2.2.4.2 TEQs and PCAs

Several papers have been published comparing the proposed PCT schemes listed in the previous section (Roberts & Thumim, 2006; Fawcett & Parag, 2010a; Starkey, 2012; Parag & Fawcett, 2014). TEQs and PCAs are described in this section as they are the most well detailed and developed of the PCT schemes, have been the subject of most of the PCT research (Fawcett, 2012), and have attracted the most political interest, undergoing pre-feasibility government studies (see Section 2.2.4.4). TEQs and PCAs were both designed for the United Kingdom economy.

TEQs are a redeveloped and updated version of Fleming's original DTQs (Fleming, 2005). They were renamed on account of confusion caused by the word "domestic" in the original title, which implied that the system only covered household emissions, rather than the entire national economy (The Fleming Policy Centre, 2019). Under TEQs, a carbon emission budget is set over 20 years, rolling forward, week by week. Individuals receive 40% of the carbon budget as allowances for free, on an equal per capita basis, to cover all carbon emissions resulting from household energy use and personal travel (excluding aviation). The remaining 60% of the budget is auctioned for use in the rest of the economy. The scheme is mandatory in its use, allowances are tradable, and transactions are carried out electronically (Fleming & Chamberlin, 2011; Starkey, 2012).

PCAs were first proposed by Hillman in 1998, and were developed further by Hillman and Fawcett in 2004. While similar to TEQs, the scope of PCAs is only household energy use and personal travel (including aviation), with a further policy required for the remainder of the economy (Roberts & Thumim, 2006, p. 13). The main difference between the schemes is coverage for children. Under PCAs, parents receive additional emissions rights, while, under TEQs, parents receive increased child benefits to cover the cost of their children's permits (Starkey, 2012, p. 9).

2.2.4.3 Public Acceptability of PCT

Many studies have assessed the public acceptability of PCT as a standalone policy or in comparison to differing policies like a carbon tax. The methodologies of the studies have included focus-group discussions (Low, 2005; Howell, 2007), surveys (Jagers, Löfgren, & Stripple, 2010), opinion polls (Bird & Lockwood, 2009), semi-structured interviews (Wallace et al., 2010), and mixed methods (Harwatt, 2008). The results are best summed up by Fawcett (2012, p. 286), and Parag and Fawcett (2014, p. 28), who reviewed all the PCT public acceptability studies, and found that when compared with other carbon reduction policies, including carbon taxation, PCT is usually the preferred option. The effectiveness of the policy and the fairness, in terms of the equal per capita principle embodied by PCT, are seen as the key benefits. However, it must be noted that some participants in PCT acceptability studies see the equal per capita principle as not always being fair, with particular groups such as the elderly requiring additional allowances (Howell, 2012, pp. 255-256; Starkey, 2012, p. 16).

A further concern of all carbon pricing schemes is the cost for low-income earners. Several studies have found carbon taxes to be regressive, disproportionally affecting more impoverished individuals, unless revenue is returned through tax cuts and rebates (Callan et al., 2009; Metcalf, 2009; Mathur & Morris, 2014; Renner, 2018; Berry, 2019; Metcalf, 2019a). In comparison, a PCT pre-feasibility study commissioned by the United Kingdom government (see Section 2.2.4.4) found PCT is a progressive policy, in which low-income earners are the winners, as their levels of emissions are generally lower (Defra, 2008b; Fawcett, 2010b, p. 6870; Chamberlin, Maxey, & Hurth, 2014, p. 420).

In the absence of any PCT trials, simulations have been used to test and compare the behavioural changes associated with the introduction of PCT, as opposed to a carbon tax. Zanni et al. (2013) found that while a carbon tax and PCT would both reduce carbon emissions, a carbon tax would result in 10.9% reduction, in comparison with a 13.3% reduction for PCT. Research by Parag et al. (2011) found that while there was mixed evidence as to whether a PCT or a carbon tax would lead to the most considerable emission reductions, a PCT would have a more significant spillover effect than a carbon tax (Parag, Capstick, & Poortinga, 2011, p. 901) where adoption of an environmental behaviour may cause people to adopt other environmentally friendly behaviours (Thøgersen & Crompton, 2009; Whitmarsh & O'Neill, 2010). Bristow et al. (2010, p. 1833) found that the public acceptability of PCT could reach 80% under the right design, in comparison with 70% for a carbon tax.

PCT may also have additional benefits over other carbon reduction policies. Proponents argue that a carbon price downstream at the point of sale has greater visibility to the consumer and may result in more considerable behavioural changes (Matthews, 2010, p. 478; Mansur, 2011, p. 191; Sumner, Bird, & Dobos, 2011, p. 3). PCT is the only emissions reduction scheme that communicates the results of differing decisions made by individuals on their carbon emissions (Fawcett & Parag, 2010a, p. 329). Fawcett (2010b) suggests that PCT would provide frequent feedback on behaviour in the form of a carbon statement, while also providing the psychological effect of having an allowance and the collective shared goal of carbon reduction. Parag and Strickland (2011) contend that PCT would increase an individual's ability to control their carbon emissions, while serving as an enabling policy, thereby boosting the uptake of new carbon reduction policies and increasing the implementation of existing policies. In addition, PCT would provide economic, psychological, and social motivations which conform to methodological approaches to behaviour change (Parag & Strickland, 2011, pp. 4-5) and may lead to mental accounting or budgeting effects, resulting in more significant reductions in carbon emissions than a carbon tax (Capstick & Lewis, 2010; Parag, Capstick, & Poortinga, 2011). Research by Whitmarsh (2009, p. 21) found that people are not willing to make sacrifices to their standards of living when they perceive that others are not sharing the responsibility for tackling climate change. This unwillingness may be tackled under the equal per capita approach of PCT.

2.2.4.4 Political Acceptability of PCT

In 2006–2007, a debate about PCT was conducted in the parliament of the United Kingdom, and the Department for Environment, Food and Rural Affairs (Defra) undertook a pre-feasibility study into PCT that included DTQs and PCAs (Chamberlin, Maxey, & Hurth, 2014, p. 420). The study examined the economic and technical acceptability of PCT (Lane, Harris, & Roberts, 2008), the public acceptability of PCT (Owen et al., 2008), the equity of PCT (Thumim & White, 2008), and the existing policy landscape (Defra, 2008a). The results found that technology was not a barrier to PCT, individuals on lower incomes would be the winners as their emission are generally lower, and that public acceptability was comparable or slightly better than alternative policies like a carbon tax; however, the costs, estimated to be around £30 per year per individual, would outweigh the benefits. Defra (2008b) ultimately concluded that the idea of PCT was ahead of its time. A month after the Defra report, the House of Commons Environmental Audit Committee published a report into PCT that was more supportive, and "regretted" the decision by Defra to discontinue PCT research. The report concluded that PCT could be essential in carbon reduction efforts, and that further research was required (Environmental Audit Committee, 2008; Fawcett, 2012, p. 285).

The costs in the Defra report were disputed (Bird & Lockwood, 2009; Fleming & Chamberlin, 2009), with some suggesting that costs may only be half as much as those identified by Defra (Lockwood, 2009). Defra's financial analysis was criticised for failing to regard additional benefits of PCT, including the fair access to energy for all individuals during carbon reduction efforts (Fleming & Chamberlin, 2011), and the importance of a sense of common purpose and an emissions cap in carbon reduction efforts (Fleming & Chamberlin, 2009). In 2011, the United Kingdom All Party Parliamentary Group on Peak Oil published a report, calling for a new feasibility study into PCT. The report received no official response from the Department of Energy & Climate Change, who later confirmed that no staff had been assigned to take responsibility for this area, despite commitments by the government to monitor ongoing research if lower costs or greater benefits were demonstrated (Chamberlin, Maxey, & Hurth, 2014, pp. 420-421). Following this, the political momentum behind PCT in the United Kingdom dissipated, and there has been no further PCT research undertaken by the government (Fawcett, 2012, p. 288; Parag & Fawcett, 2014, p. 28)

There has been little political interest looking a PCT as a policy option outside of the United Kingdom. The Sustainable Development Council investigated Cap and Share in Ireland, but there was no further government interest in the scheme (Parag & Fawcett, 2014, p. 28). While resolutions were passed in support of a PCT feasibility study by Sweden’s Left Party and Green Party, and PCT is a core policy for the Green Party of England and Wales, broader interest in PCT is sustained by academia, non-governmental organisations (NGOs), and community groups (Chamberlin, Maxey, & Hurth, 2014, p. 421).

2.2.4.5 Trialling PCT

While there is considerable literature on PCT, there is no evidence of any PCTS or PCMS trials outside of the current research. In the absence of any trials, PCT simulations and grassroots movements have explored some of the theory behind the proposed PCT schemes as outlined below.

A simulated PCTS was used by Capstick and Lewis (2010) to assess how people might budget their allocated carbon allowances over time and purchase additional credits if needed. The trial showed that a declining allowance or a more restrictive allowance resulted in more carbon-conscious decisions by the participants. Significant correlations were found between the level of climate change concern and support for PCT, and self-ascribed responsibility for climate change and support for PCT. A significant inverse correlation was also found between footprint size and support for PCT, thereby indicating that those with smaller carbon footprints were more likely to support PCT (Capstick & Lewis, 2010, pp. 380-381).

In 2006, a grassroots community-based movement called Carbon Rationing Action Groups (CRAGs) started in the United Kingdom. The CRAGs were comprised of 8–12 members on average, and voluntarily set themselves an equal per capita yearly carbon allowance, tracked their emissions throughout the year, and in some cases imposed financial penalties for not meeting the target (Parag & Fawcett, 2014, p. 27). Howell (2012) found that CRAG members had generally been trying to reduce their carbon emissions before joining a group, and their carbon emissions were on average 5% below the United Kingdom national average. In their first year as a member of a CRAG, average per capita carbon footprint reduced by 32%. One of the main changes identified was the increased carbon literacy of the group members (Howell, 2012). In 2008, there were 25 such groups throughout the United Kingdom; however, most groups had ceased to exist by 2010, as their members had reduced their carbon emissions as much as they could, and the groups struggled to gain new members (Hielscher, 2013).

Trialling PCT on a larger scale would require some form of government support, and PCT is perceived as a political risk (Bird & Lockwood, 2009) since it challenges the conventional wisdom about the extent to which governments should enforce personal consumption (Parag & Eyre, 2010). Parag and Fawcett (2014) hypothesise that the main barrier in implementing PCT at present is the lack of political will. Other barriers include economic and technical feasibility, and the responsibility of individuals versus governments and industry in carbon reduction efforts (Parag & Fawcett, 2014, p. 23).

To increase interest in the introduction of PCT, Fawcett (2012, p. 289) suggests a voluntary PCT trial. To explore fully the case for PCT, Parag and Fawcett (2014, p. 30) recommend that approaches should include researching voluntary PCT. Guzman and Clapp (2017, p. 623) suggest that starting with a voluntary program would be the best approach to introduce PCT, while Capstick and Lewis (2010, p. 382) hypothesise that a voluntary PCT scheme may offer insight into the individual and social responses to PCT. The research presented in this thesis is intended to bridge these gaps in the literature and Parag and Fawcett (2014, p. 30), Chamberlin, Maxey, and Hurth (2014, p. 421), and Guzman and Clapp (2017, pp. 620-621) have all identified the NICHE PCMS trial as the first research of its kind into voluntary usage of a system that represents several significant aspects of a PCTS.

The literature surrounding the most well-developed PCT schemes, TEQs and PCAs, was taken into consideration by the author when designing and developing the NICHE PCMS. In their report to Defra, Roberts and Thumim (2006) identified the following questions that need to be considered before the development and implementation of any PCTS:

- Who participates in the system: individuals, organisations, or both?
- What proportion of the emissions cap is allocated to individuals versus organisations, and on what basis?
- Do children receive an allowance, and if so, what size?
- Are permits issued free of charge, and if not, how are they distributed?
- Which fossil fuels or activities are included in the scheme?

These questions were considered and addressed in the design and development of the NICHE PCMS as follows:

- Only individuals participated in the NICHE PCMS trial, and the trial covered household energy and personal transport as outlined in PCAs (Fawcett & Parag, 2010a, p. 330; Parag & Fawcett, 2014, p. 26); however, PCAs cover aviation, and this was excluded owing to the difficulties faced in implementing it in the system. While this was regarded as acceptable as TEQs do not cover aviation (Roberts & Thumim, 2006, p. 4), it must be noted that the exclusion of air travel reduced the flexibility of the PCMS trial and possible opportunities for emission reductions. Minimising air travel was one of the main ways CRAG members cut their emissions, and the inclusion of air travel in any PCT scheme provides individuals who have few other options an opportunity to decrease their carbon emissions (Howell, 2012, p. 257);
- Owing to the lack of support from the banking sector in using their infrastructure, it was not possible to implement a carbon bank, and it was unacceptable politically to enforce a carbon cap. In its place, a non-

compulsory 10% carbon emissions reduction target was assigned to each household, based on the average carbon emissions for a household of that size. The target was introduced after collecting six months of baseline emissions data. This is discussed further in Section 3.2.4 in the next chapter;

- While there are some differences in allocations for children under PCAs and TEQs, children are not provided carbon allocations equal to adults in either scheme. Starkey (2012, p. 17) has argued for and against the fairness of including children in permit allocations. However, research by Bristow et al. (2010, p. 1833) found that permit allocations that include children were more publicly acceptable than those that do not include children. As a result, children were included and received an equal carbon allocation when the reduction target was calculated for their household. The decision to give children an equal carbon allocation is discussed in Section 3.2.4;
- As the trial covered household energy and personal transport, the carbon emissions from all fossil fuel usage used for these purposes (gas, electricity, petrol and diesel) was included.

2.3 Measuring PCMS Usage

This section of the chapter summarises the literature that was reviewed to identify the possible attitudes and behaviours that may influence an individual to participate in a voluntary PCMS trial and how best to measure the usage and acceptance of the NICHE PCMS.

2.3.1 Information System Success and Technology Acceptance

An information system is a set of "interrelated computer components that collects, processes, stores and provides as output the information needed to complete tasks" (Satzinger, Jackson, & Burd, 2012). The NICHE PCMS is an example of an information system. Several competing models have been proposed to determine whether an information system is successfully adopted by its users that can be separated into two groups, *information system success* and *technology acceptance*. To better understand which factors could affect the usage of an information system like the NICHE PCMS, the literature covering the *information system success* and *technology acceptance* models was reviewed.

The *information system success* models reviewed include:

- DeLone and McLean Information System Success Model (1992); and
- DeLone and McLean Information System Success Model Revisited (2002, 2003).

The *technology acceptance* models reviewed include:

- The Technology Acceptance Model (TAM – 1989);
- The Technology Acceptance Model 2 (TAM2 – 2000);
- The Technology Acceptance Model 3 (TAM3 – 2008); and
- Unified Theory of Acceptance and Use of Technology (UTAUT – 2003).

While not designed for information systems, the Theory of Reasoned Action (TRA – 1975; 1980) was reviewed as most of the early information system models were adapted in part from the TRA (Davis, Bagozzi, & Warshaw, 1989, p. 983).

The *technology acceptance* models were regarded as preferable to assess the NICHE PCMS as they measure *Usage Behaviour*. In contrast, the *information system success* models measure *Organizational Impact* (DeLone and McLean) and *Net Benefits* (DeLone and McLean revisited), which are more in line with business information systems in a workplace setting. From the *technology acceptance* models, TAM2 was chosen as the theoretical framework to underpin the research for this project, rather than UTAUT, as the constructs in TAM2 were felt to be more closely aligned with the current research and a better fit for an information system like the NICHE PCMS. Although newer, TAM3 was not chosen because the additional determinants of *perceived ease of use* were not felt to be relevant to the research. This is discussed further in Section 2.3.1.4 of this chapter. However, the research literature surrounding TAM3 was relevant as it is an extension of TAM2, and as a result, TAM2 and TAM3 are covered in greater detail in this section than the other models.

2.3.1.1 Theory of Reasoned Action (1975, 1980)

Proposed by Martin Fishbein and Icek Ajzen in 1967, the Theory of Reasoned Action (TRA) is an intention model from social psychology that has proven successful in predicting and explaining the relationship between attitudes and behaviours across a range of areas (Davis, Bagozzi, & Warshaw, 1989, p. 983). The TRA proposes that the decision to engage in a particular behaviour is influenced by pre-existing attitudes and behavioural intentions, and the subjective norms associated with the behaviour (Hale, Householder, & Greene, 2002, pp. 259-260).

While proving useful for explaining and predicting an individual's behaviour, the TRA has limitations and has received criticism, as attitudes, and subjective norms are not equally weighted in predicting behaviour (Miller, 2005, p. 127). This led Ajzen to propose an adaption of the TRA in 1985, referred to as the Theory of Planned Behaviour. The TRA model is shown in Figure 2-2 below.

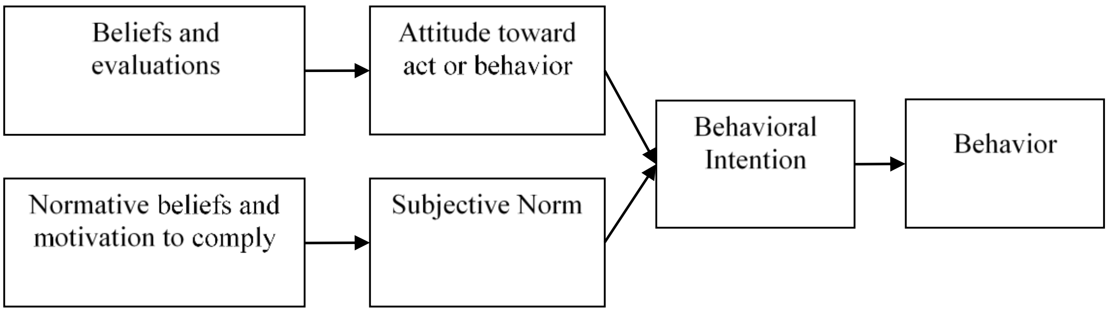

Figure 2-2 Theory of Reasoned Action
(Davis, Bagozzi, & Warshaw, 1989, p. 984)

2.3.1.2 Technology Acceptance Models

2.3.1.2.1 The Technology Acceptance Model (TAM – 1989)

Using the TRA as a theoretical basis, Davis (1989, p. 983) developed the Technology Acceptance Model (TAM) to explain user acceptance and the usage behaviour of information systems. While TAM has since been revised and extended, as the first model designed to predict a user's usage and acceptance of a new technology, it is a valid starting point when reviewing the technology acceptance literature.

TAM posits that two factors motivate an individual to use a new technology, *perceived usefulness* and *perceived ease of use* (Davis, Bagozzi, & Warshaw, 1989, p. 983; Miller, 2005, p. 127). TAM defines *perceived usefulness* as "the degree to which a person believes that using a particular system would enhance his or her job performance" and *perceived ease of use* as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989, p. 320). TAM is shown in Figure 2-3 below.

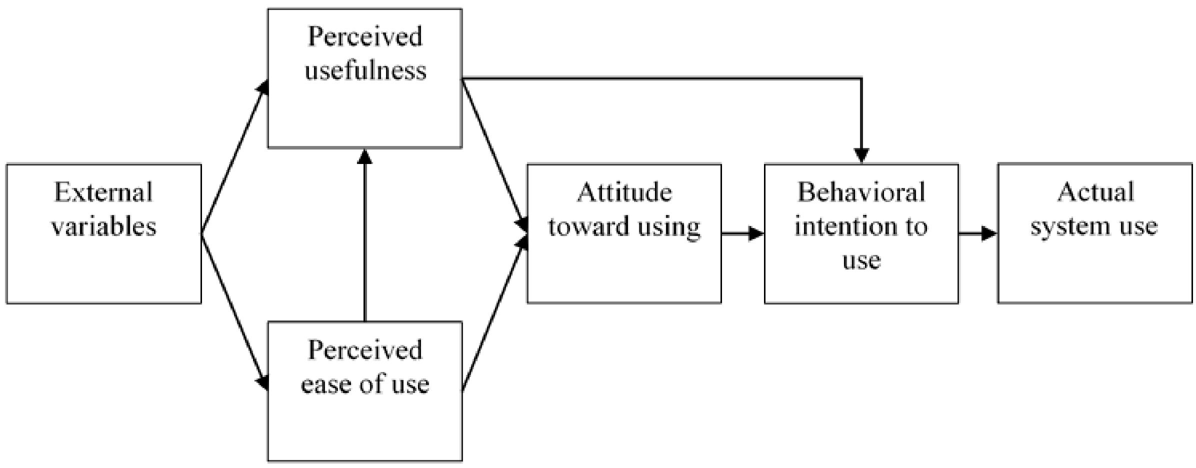

Figure 2-3 Technology Acceptance Model
(Davis, Bagozzi, & Warshaw, 1989, p. 984)

2.3.1.2.2 The Technology Acceptance Model 2 (TAM2 – 2000)

In the decade after its development, numerous studies showed that TAM consistently explained about 40% of the variance in information system usage (Venkatesh & Davis, 2000, p. 186). Nevertheless, while *perceived usefulness* was consistently found to be a strong determinant, *perceived ease of use* exhibited a less consistent effect, and TAM was unable to explain why a system was useful or easy to use (Venkatesh & Davis, 2000, p. 187). Since *perceived usefulness* was fundamental in driving usage, Venkatesh and Davis (2000) identified that a better understanding of the determinants of *perceived usefulness* would enable organisations to increase the adoption of new information systems.

In 2000, Venkatesh and Davis proposed the Extended Technology Acceptance Model, referred to as TAM2. TAM2 introduced additional key determinants of *perceived usefulness* in terms of social influence and cognitive instrumental processes. The new constructs and their definitions that TAM2 defines are:

Social influence processes

- *Subjective Norm* – The degree to which an individual perceives that most people who are important to them think they should or should not use the system;
- *Voluntariness* – The degree to which an individual perceives system use to be non-mandatory;
- *Experience* – The experience an individual has using the system; and
- *Image* – The degree to which system use is perceived to enhance an individual's status in a social system.

Cognitive instrumental processes

- *Job Relevance* – The degree to which an individual believes that the target system is applicable to his or her job;
- *Output Quality* – The degree to which an individual believes that the system performs his or her job tasks well; and
- *Result Demonstrability* – The degree to which an individual can attribute gains in their job performance to the system.

TAM2 is shown in Figure 2-4 below.

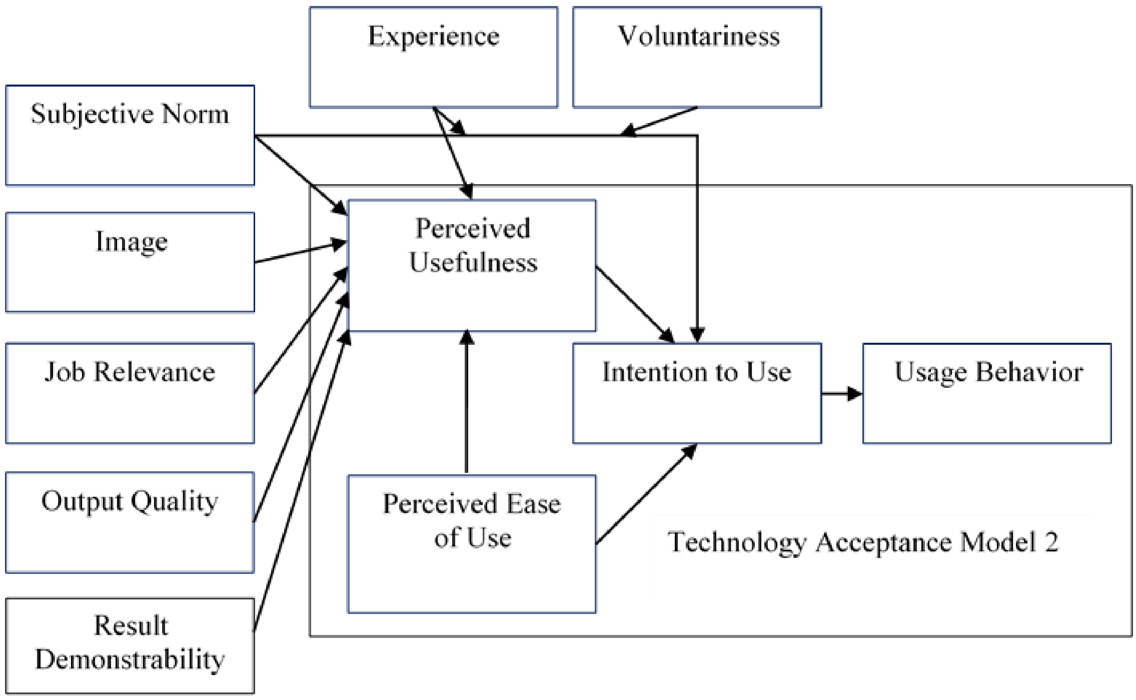

Figure 2-4 Technology Acceptance Model 2
(Venkatesh & Davis, 2000, p. 188)

The TAM2 hypotheses (Venkatesh & Davis, 2000, p. 188) listed below are included to highlight the relevance of the model with the aims of this research, and gain an understanding of the relationships between the constructs when gauging the usage and acceptance of the NICHE PCMS:

- HYPOTHESIS 1a. Subjective norm will have a positive direct effect on intention to use when system use is perceived to be mandatory;
- HYPOTHESIS 1b. Subjective norm will have no significant direct effect on intention to use when system use is perceived to be voluntary;
- HYPOTHESIS 1c. Voluntariness will moderate the effect of subjective norm on intention to use;
- HYPOTHESIS 2. Subjective norm will have a positive direct effect on perceived usefulness;
- HYPOTHESIS 3a. Subjective norm will have a positive effect on image;
- HYPOTHESIS 3b. Image will have a positive effect on perceived usefulness;
- HYPOTHESIS 4a. The positive direct effect of subjective norm on intention for mandatory systems will attenuate with increased experience;
- HYPOTHESIS 4b. The positive direct effect of subjective norm on perceived usefulness will attenuate with increased experience for both mandatory and voluntary systems;
- HYPOTHESIS 5. Job relevance will have a positive effect on perceived usefulness;
- HYPOTHESIS 6. Output quality will have a positive effect on perceived usefulness;

- HYPOTHESIS 7. Result demonstrability will have a positive effect on perceived usefulness; and
- HYPOTHESIS 8. Perceived ease of use will have a positive effect on perceived usefulness.

2.3.1.2.3 The Technology Acceptance Model 3 (TAM3 – 2008)

While the determinants of *perceived usefulness* were identified and included in TAM2, the determinants of *perceived ease of use* were not. As a result, the Determinants of Perceived Ease of Use Model was proposed by Venkatesh (2000) based upon the anchoring and adjustment framing of human decision making. The model posits that "individuals will form early perceptions of perceived ease of use of a system based on several anchors related to individuals' general beliefs regarding computers and computer use" (Venkatesh & Bala, 2008, p. 278). Venkatesh hypothesised that, once individuals gain experience with a new system, two adjustments would also play a role in determining *perceived ease of use*. The anchors and adjustments that Venkatesh hypothesised as determining *perceived ease of use* are as follows:

Anchors

- *Computer Self-Efficacy* – The degree to which an individual believes that he or she has the ability to perform a specific task/job using the computer;

- *Perception of External Control* – The degree to which an individual believes that organisational and technical resources exist to support the use of the system;
- *Computer Anxiety* – The degree of an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers; and
- *Computer Playfulness* – the degree of cognitive spontaneity in microcomputer interactions.

Adjustments

- *Perceived Enjoyment* – The extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use; and
- *Objective Usability* – A comparison of systems based on the actual level rather than perceptions) of effort required to completing specific tasks.

TAM2 and the Determinants of Perceived Ease of Use Model were combined by Venkatesh and Balla (Venkatesh & Bala, 2008, p. 278) to create the Integrated Model of Technology Acceptance, referred to as TAM3, as shown in Figure 2-5 below.

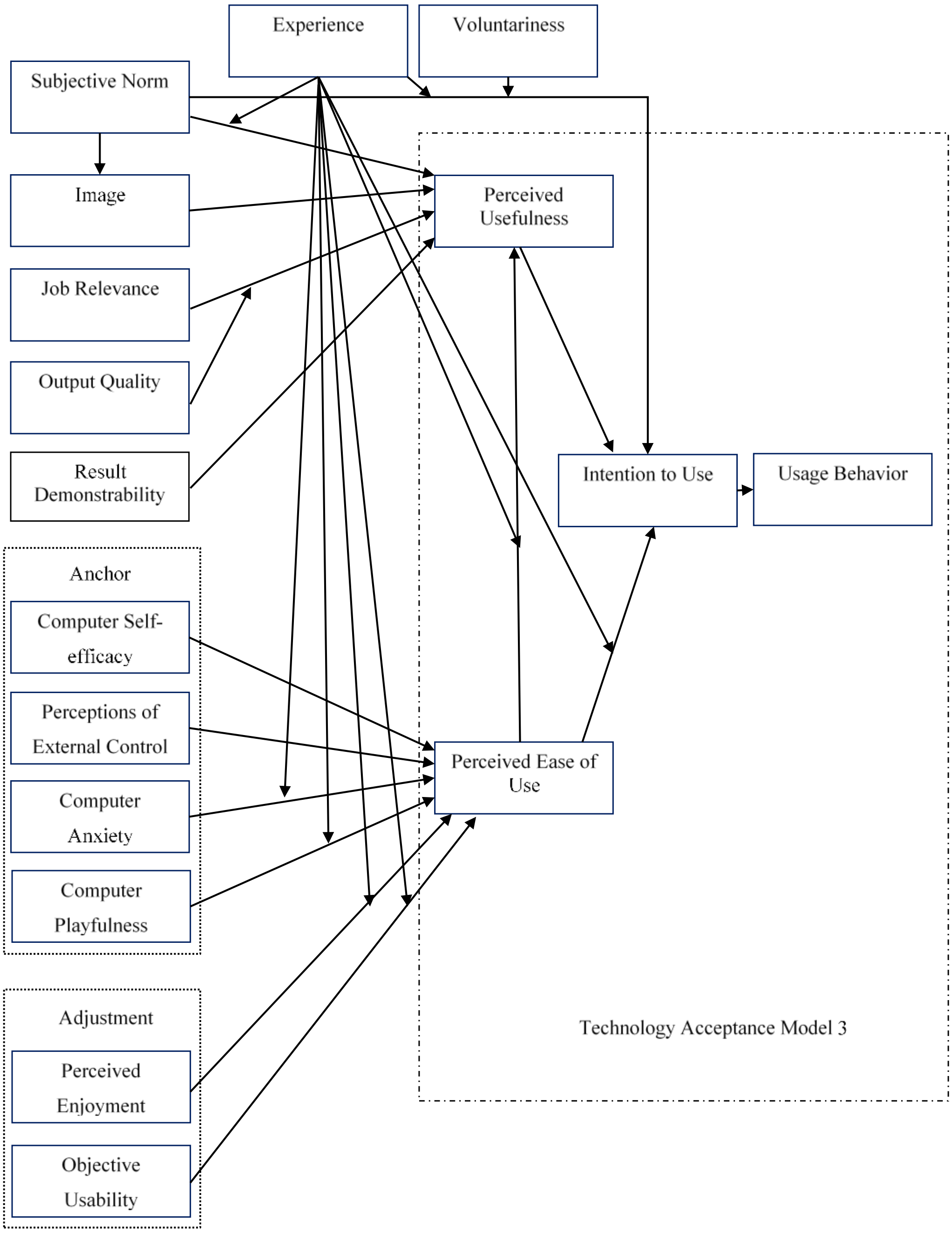

Figure 2-5 Technology Acceptance Model 3
(Venkatesh & Bala, 2008)

2.3.1.2.4 Unified Theory of Acceptance and Use of Technology (UTAUT – 2003)

The Unified Theory of Acceptance and Use of Technology (UTAUT) was proposed by Venkatesh et al. (2003) to create a unified model that integrated eight competing technology acceptance models.

The eight models that the UTAUT integrates are as follows:

- Theory of Reasoned Action (Ajzen and Fishbein, 1967; 1975; 1980);
- Technology Acceptance Model (Davis, 1989) and the extended Technology; Acceptance Model (Venkatesh and Davis, 2000);
- Motivational Model (Vallerand, 1997);
- Theory of Planned Behaviour (Ajzen, 1991);
- Combined TAM and Theory of Planned Behaviour (TPB) (Taylor and Todd, 1995);
- Model of PC Utilization (Thompson et al., 1991);
- Innovation Diffusion Theory (Rogers, 1995) adapted for information systems by Moore and Benbasat (1991); and
- Social Cognitive Theory (Bandura, 1986) adapted for information systems by Compeau and Higgins (1995).

From these models, seven constructs were identified as being “determinants of intention or usage” (Venkatesh et al., 2003, p. 446). Of these seven, four constructs, *performance expectancy*, *effort expectancy*, *social influence*, and *facilitating conditions* were determined to “play a significant role as direct determinants of user acceptance and usage behaviour" (Venkatesh et al., 2003, p. 447). Within these four constructs, Venkatesh et al. theorised that there were four moderators, *gender*, *age*, *experience*, and *voluntariness of use*, that will mediate the impact (Venkatesh et al., 2003, pp. 447-453). The UTAUT model is shown in Figure 2-6 below.

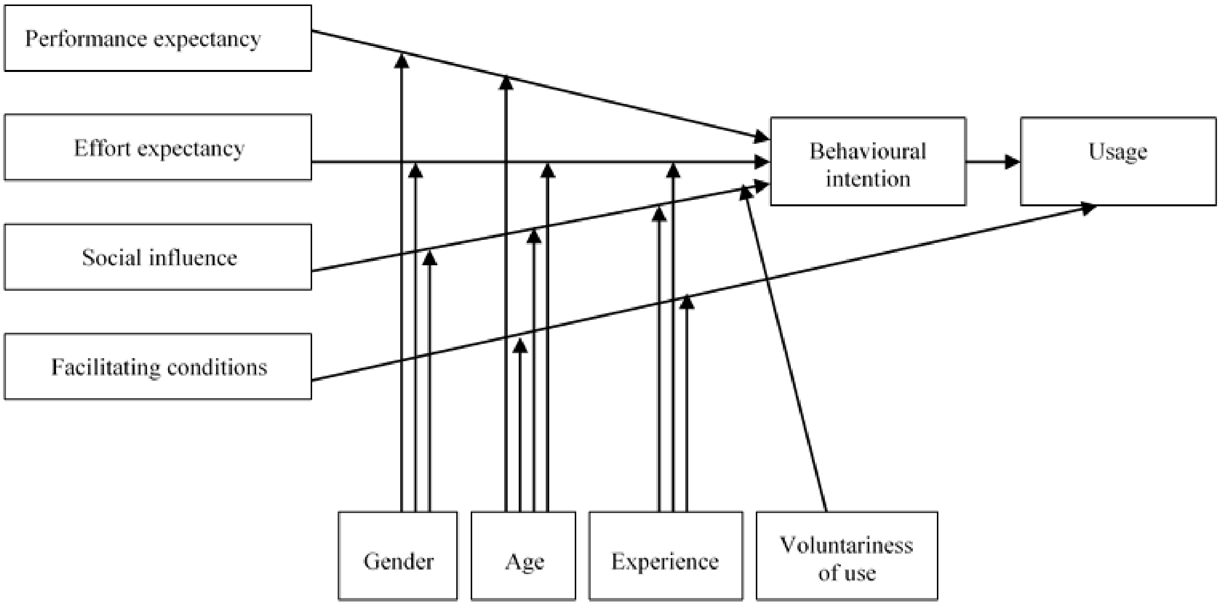

Figure 2-6 Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003, p. 447)

2.3.1.3 Information System Success Models

2.3.1.3.1 The DeLone and McLean Information System Success Model (1992)

The DeLone and McLean (1992) information System Success model was based on a review of the research conducted throughout the 1970s, 1980s, and early 1990s in an attempt to identify the critical determinants of information system success. After reviewing the available research, DeLone and McLean (1992) concluded that there were many determinants of information system success. However, all of the determinants of information system success could be placed into the following six categories that are interrelated and interdependent: *system quality*, *information quality*, *use*, *user satisfaction*, *individual impact*, and *organizational impact*. The DeLone and McLean Information System Success Model is shown in Figure 2-7 below.

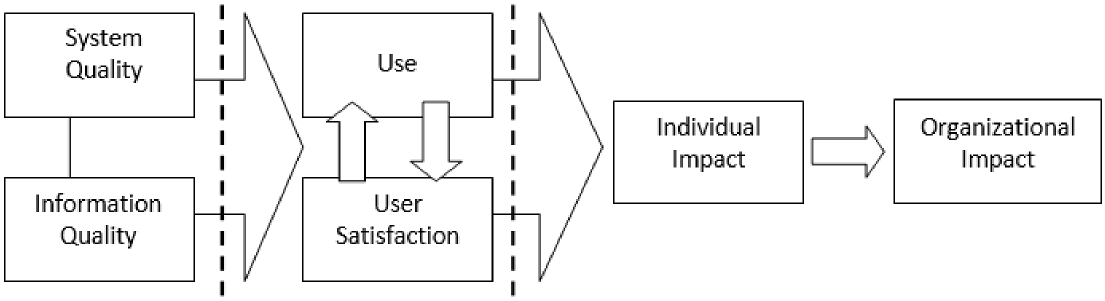

Figure 2-7 Delone and Mclean Information System Success Model (DeLone & McLean, 1992, p. 87)

2.3.1.3.2 The DeLone and McLean Information System Success Model Revisited (2002, 2003)

Based upon further research undertaken by DeLone and McLean and many other researchers in the decade following the release of their original model, DeLone and McLean revised their model in 2002. The main changes were (DeLone & McLean, 2002):

- *Service Quality* was added as a measurement of information system success;
- *Use* was split into *Intention to Use* and *Use*; and
- *Organizational Impact* and *Individual Impact* were replaced with *Net Benefits.*

The revised DeLone and McLean Information System Success Model is shown in Figure 2-8 below.

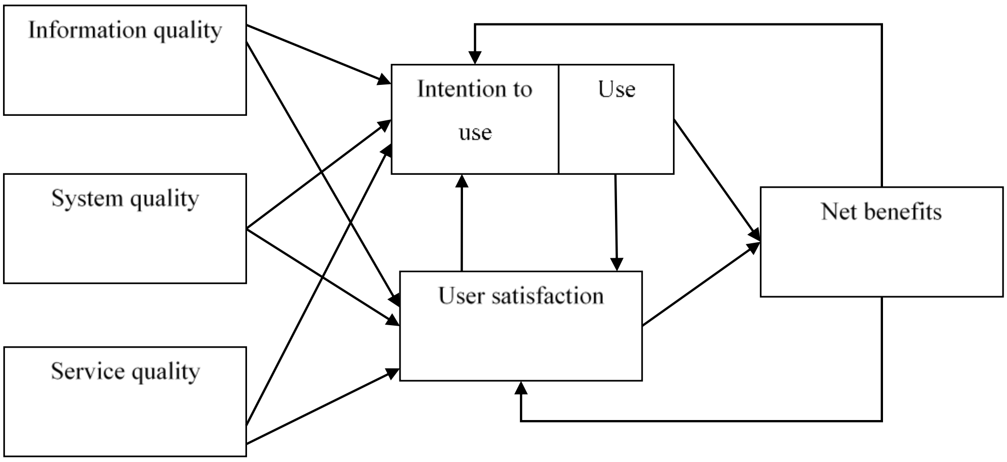

Figure 2-8 Revised Delone and Mclean Information System Success Model (DeLone & McLean, 2003, p. 24)

2.3.1.4 Information System Summary

TAM2 was chosen as the theoretical framework to underpin the research for this project and measure the user acceptance and usage behaviour of the NICHE PCMS. However, given that TAM2 was designed to measure the usage of business information systems in a workplace context (Venkatesh & Bala, 2008, p. 273), rather than public information systems like the NICHE PCMS with an environmental context, not all the constructs in the model were relevant when measuring the usage of the NICHE PCMS. The constructs from TAM2 that were deemed applicable for an information system like the NICHE PCMS were the dependent variable *Usage Behaviour*, and the independent variables *Perceived Usefulness*, *Perceived Ease of*

Use, *Intention to Use*, *Voluntariness*, and *Subjective Norm*. These constructs provided the basis for the development of the conceptual model that is described in Section 3.3.4.4 of the next chapter. The *Experience*, *Image*, *Job Relevance*, *Output Quality*, and *Result Demonstrability* constructs were felt to be more relevant for business information systems and, as such, were not included in the conceptual model.

When considering the technology acceptance models, TAM2 was chosen over UTAUT, as the constructs in TAM2 were felt to be a better fit to measure usage of an information system with an 'environmental' focus like the NICHE PCMS. However, TAM2 does not account for the impact of age and gender, both of which have been shown to influence concern about, and willingness to act on climate change (see Section 2.3.2.2). Age and gender are included in UTAUT as moderators and are hypothesised to mediate the impact the constructs in the model have on usage behaviour. Owing to the sample size of the post-PCMS survey, it was not possible to moderate the results of the analysis by age and gender (see Section 7.4). Therefore, age and gender were not included in the proposed conceptual model. Given that age and gender have been shown to influence attitudes towards climate change, these moderators from UTAUT should be considered in future technology acceptance research for systems like the NICHE PCMS.

As discussed at the start of this section, while newer, TAM3 was not chosen because the additional determinants of *perceived ease of use* were not felt to be relevant to the research. However, given the remaining constructs in TAM3 are identical to the constructs in TAM2, the research conducted by Venkatesh and Bala (2008) in their development of TAM3 was an important reference. The survey items and scales used to gather data about the TAM2 and TAM3 constructs influenced the design of the technology acceptance survey items in the post-PCMS survey (see Section 3.3.4.4). The statistical techniques used to validate TAM2 and TAM3 helped to inform the data analysis to be undertaken for the research (see Section 3.4).

After reviewing the available literature, it was determined that the research presented herein represents the first study of its kind to use a technology acceptance model to examine the usage of a PCMS. For researchers studying technology acceptance and the usage of an information system with an 'environmental' focus, as opposed to a 'business' focus, the research reported in this thesis will provide a starting point for additional factors that may need to be borne in mind. In the next sections, other factors that may influence the usage of the NICHE PCMS are considered.

2.3.2 Beliefs Surrounding Climate Change

The literature shows that understanding popular perceptions and opinions on climate change is critically important for public engagement and support for action, given the profound changes required for mitigation and adaptation (Capstick et al., 2015, p. 53; Poortinga et al., 2019, p. 25). This section discusses the scientific consensus on the causes of climate change, the general public's opinions and perceptions of climate change, and possible reasons for climate change scepticism.

2.3.2.1 Scientific Consensus on Climate Change

The literature surrounding climate change shows that climate scientists overwhelmingly agree that human activity is the cause of climate change. Using a dataset of 1,372 climate researchers, Anderegg et al. (2010, p. 12108) ranked them based on their publication numbers and citation data and found that only 2% of the top 50 climate researchers, 3% of the top 100 climate researchers, and 2.5% of the top 200 climate researchers remain unconvinced by the evidence of climate change as outlined by the IPCC. Cook et al. (2013, p. 1) found that 97% of the peer-reviewed scientific literature that expressed an explicit position on anthropogenic climate change agreed that it is occurring. In a survey conducted by Doran et al. (2009, p. 23), 97.4% of actively publishing climatologists agreed that “human activity is a significant contributing factor in changing mean global temperatures”. Research by Powell (2015, p. 121) found that, in 2013 and 2014, only 4 of 69,406 authors of peer-reviewed articles on climate change rejected that it was mainly caused by humans.

2.3.2.2 Popular Opinions and Perceptions of Climate Change

While there may be a scientific consensus, members of the public are unaware that climate scientists overwhelmingly agree with the science behind climate change and agree that human activity is the cause of it. Public polling by the Pew Research Centre in the United States found that only 16% of conservative Republicans, 13% of moderate Republicans, 29% of moderate Democrats, and 55% of liberal Democrats believe that, among climate scientists, there is widespread consensus about the causes of global warming (Funk & Kennedy, 2016, p. 6). While the figures may have changed since 2011, Poortinga et al. (2011, p. 1020) found that, in the United Kingdom, only 57% of the British public believed that most scientists agree that human activity is the cause of climate change. While no literature could be found outlining the Australian public's view on the scientific consensus surrounding global warming, research conducted by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) found that only 31.5% of Australians base their opinion on climate change on scientific research (Leviston, Greenhill, & Walker, 2015, p. 8).

The evidence also shows that there are members of the public who are sceptical about climate change or deny that climate change is taking place. Others agree that climate change is happening, but do not agree that human activity is causing it, with some contending that climate change is mainly or indeed entirely the result of natural processes (Capstick et al., 2015, p. 35; Carlton et al., 2015; Leviston, Greenhill, & Walker, 2015, p. 8; Funk & Kennedy, 2016, p. 22; Funk & Hefferon, 2019, pp. 7-8; Department for Business, Energy & Industrial Strategy, 2020, p. 11). The CSIRO found that, while 84.5% of Australians believe that climate change is happening, 38.6% believe it is just a natural fluctuation in the earth's temperatures, compared with the 45.9% who believe that humans are mainly causing it (Leviston, Greenhill, & Walker, 2015, p. 4). In the United States, only 49% of Americans believe that human activity contributes a great deal to climate change, while 30% say human actions have some role in climate change, and 20% believe human activity plays not much, or no role at all in climate change (Funk & Hefferon, 2019, pp. 7-8). Similar results were found on Norfolk Island. The pre-PCMS analysis found that, while 93.1% of survey respondents think that climate change is happening, 31.9% believe it is just a natural fluctuation in the earth's temperatures, compared with 61.1% of respondents who believe that humans are mainly causing it (Hendry, 2014, p. 105). The post-PCMS analysis (see Section 4.3.1) found almost identical results.

Political values are a critical determinant of climate change scepticism, with individuals holding conservative political beliefs being far more likely to believe that climate change is a natural phenomenon (Poortinga et al., 2019, p. 26). Figure 2-9 below depicts the voting behaviour of participants from the 2015 "CSIRO Australian attitudes to climate change" survey compared to their thoughts about climate change. The chart shows that 76% of survey participants who voted for the Australian Greens in the 2013 federal election thought climate change was human-induced compared to 17% who thought it was a natural fluctuation in the earth's temperature. At the other end of the political spectrum, only 22% of survey participants who voted for the National Party of Australia, a conservative-leaning party with a strong powerbase in rural areas, thought that climate change was human-induced. It must be noted that, outside Australia, the term 'liberal' denotes a political persuasion that is left of centre, although, in Figure 2-9 below, the term 'liberal' refers to the Liberal party, which would generally be regarded as right of centre in Australia.

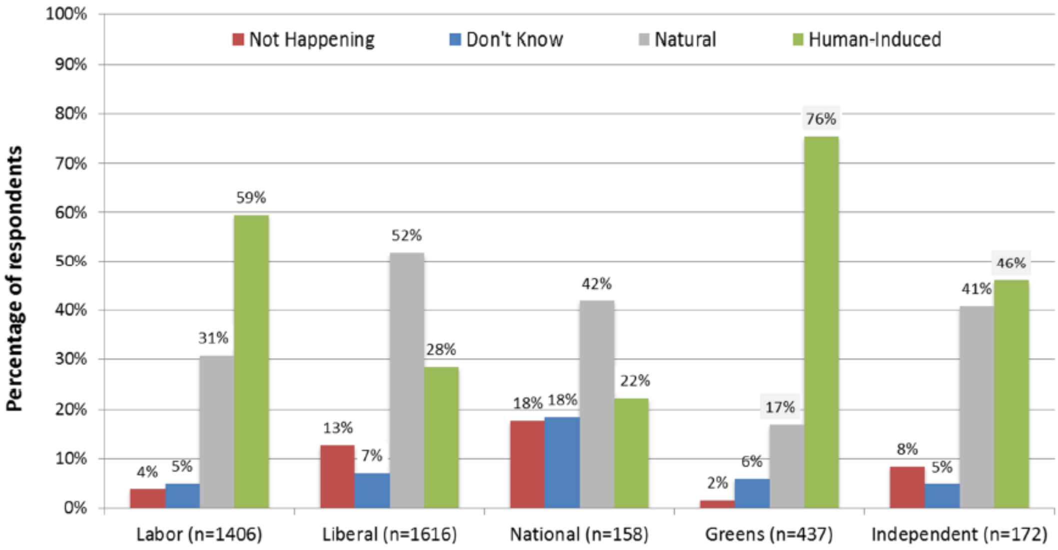

Figure 2-9 Opinions about Climate Change vs. Voting Behaviour Australian Federal Election (Leviston, Greenhill, & Walker, 2015, p. 44)

Similar results were found in the United States. Pew Research found only 15% of conservative Republicans and 34% of moderate Republicans believe in anthropogenic climate change. In contrast, 63% of moderate Democrats and 79% of liberal Democrats reported that they believe in anthropogenic climate change (Funk & Kennedy, 2016, p. 9). These figures are matched by a 2018 Gallup poll that found that only 35% of Republicans believe climate change is caused by human activity, compared with 89% of Democrats (Gallup, 2017).

In a review of the climate change perception literature, Poortinga et al. (2019) reported that the link between conservative political beliefs and doubt about the causes of climate change that was outlined in the previous paragraph is a common pattern in a number of countries, particularly among men. Referred to as the *white male effect* or *conservative male effect*, the research in this area consistently shows that white men, especially conservative ones, are generally more accepting of environmental risks, including those of climate change (Poortinga et al., 2019, pp. 25-26). In contrast, the literature shows that women convey greater scientific knowledge and express slightly greater concern about climate change than men (McCright, 2010, p. 66). Women also exhibit greater pro-environmental attitudes and are more likely to engage in private pro-behaviours such as recycling (Xiao & McCright, 2014, p. 241). An analysis of 250,000 tweets and retweets on Twitter by Holmberg (2014, p. 811) found that women were significantly more likely to mention "campaigns and organizations with a convinced attitude towards the anthropogenic impact on climate change, while male tweeters mention significantly more private persons and usernames with a sceptical stance".

Research points to a growing scepticism about the causes of climate change and a decrease in public concern in the late 2000s, particularly in the United Kingdom, the United States and Australia (Capstick et al., 2015). A possible reason for this is the media, with most of the uncontested sceptical coverage occurring in the United States and the United Kingdom (Painter & Ashe, 2012, p. 1). Conservative foundations and think-tanks have also promoted climate change scepticism in these countries (Dunlap & McCright, 2010, p. 240). Other explanations include issue fatigue, distrust, the deepening politicisation of the issue and the impact of the global financial crisis (Pidgeon, 2012, p. 85). Scruggs and Benegal (2012, p. 505) found that beliefs about the existence and seriousness of climate change have declined dramatically since the global financial crisis of 2008 and that the economic downturn was partly to blame. Unusual weather events such as abnormalities in temperature, severe rains, and flooding can also affect public perception, increasing concern about climate change, at least temporarily (Sisco, Bosetti, & Weber, 2017). Indeed, researchers from Columbia University found that climate change judgements can depend on the perception that the weather seems warmer or colder than usual (Zaval et al., 2014). In Australia, climate change sceptics were likely to select ‘common sense’, ‘the weather’, or ‘historical events’ as the basis of their beliefs (Leviston, Greenhill, & Walker, 2015).

Age has also been shown to influence climate change scepticism. When reviewing the climate change perception literature, Poortinga et al. (2019) found that older people are more tightly integrated into prevailing social structures and value orientations, and as a result, may have more to lose owing to the changes required to address climate change. There is also evidence that as people age, they are likely to become more politically conservative and, as discussed earlier in this section, this is one of the strongest determinants of climate change scepticism (Poortinga et al., 2019, p. 26). In comparison, Pew Research found that those in the Millennial and Generation Z age groups are more likely than those in older age groups to support efforts aimed at curbing climate change (Funk & Hefferon, 2019).

2.3.2.3 Climate Change Beliefs and the NICHE PCMS

The PCT simulation used by Capstick and Lewis (2010) that was described in Section 2.2.4.5 of this chapter was the only research found that explored the relationship between levels of concern and self-ascribed responsibility for climate change, and support for PCT. However, the research did not explore climate change scepticism and support for PCT. While extensive research has been conducted into public perceptions of climate change and climate change scepticism (Capstick et al., 2015), a thorough search of the relevant literature found no research on climate change scepticism and voluntary PCT usage. To the best of the author's knowledge, the research conducted in this thesis is thought to be the first research of its kind to examine the relationship between anthropogenic climate change beliefs and voluntary usage of a system that represents several significant aspects of a PCTS.

2.3.3 Environmental Attitudes and Behaviours

Capstick and Lewis (2010, p. 382) identified that future research should examine PCT according to environmental attitudes. This section discusses the link between environmental attitudes and behaviours, and possible links with voluntary PCMS usage.

2.3.3.1 The Differences in Attitudes and Behaviours

The literature shows that, in Western countries, most people care about the environment. Research by Pew in the United States found that 75% of Americans say that they are "particularly concerned about helping the environment" (Funk & Kennedy, 2016, p. 17). The vast majority (94%) of Europeans agree that the protection of the environment is important to them (European Commission, 2017, p.

4), while, in Australia, the World Wide Fund for Nature (WWF, 2018) found that 80% of Australians agree that if “we don’t act now, we’ll never control our environmental problems”. Planet Ark (2018, p. 8) found that 91% of Australians are concerned about the environment and sustainability.

However, the same literature shows that these environmental concerns do not always translate into behaviours. Only 20% of Americans describe themselves as someone who tries to protect the environment all the time (Funk & Kennedy, 2016, p. 17) and only 27% of Europeans agree they are doing enough to protect the environment (European Commission, 2017, p. 16). In Australia, less than half of the population thinks they do enough when it comes to the environment and sustainability (Planet Ark, 2018, p. 11). Further, the literature shows that, when environmental behaviours are undertaken, the driver is frequently financial. When Australians were asked about their motivations for pro-environmental behaviours, the most common reason given was financial (Leviston et al., 2013, p. 9). Research in the United Kingdom found that a reduction in energy use is usually for economic reasons rather than environmental concern (Whitmarsh, 2009, p. 21). Behaviours such as cycling for daily travel necessities for health reasons (Passafaro et al., 2014), following a vegan diet for health or ethical reasons (Radnitz, Beezhold, & DiMatteo, 2015), or opting for consumption simplicity for ethical or lifestyle reasons (Shaw & Newholm, 2002) are all pro-environmental. Nevertheless, they are often undertaken for reasons not directly related to the environment.

2.3.3.2 Value Action Gap

The difference between an individual's attitudes and beliefs and their behaviours is known as the 'value-action gap' or 'attitude-action gap' (Godin, Conner, & Sheeran, 2005). This gap is particularly prevalent in environmental policy (Blake, 1999; Flynn, Bellaby, & Ricci, 2009, p. 159). While attitudes usually affect actions, this is often not true when it comes to environmental attitudes and actions (Kollmuss & Agyeman, 2002; Frederiks, Stenner, & Hobman, 2015), especially when there is an additional cost or trade-off for the consumer (Olson, 2013). While individuals may report feeling positive about environmental behaviours, such as sustainable products or renewable power sources, these beliefs do not reliably translate into pro-environmental choices when purchasing products or services (Kennedy et al., 2009, p. 151; Frederiks, Stenner, & Hobman, 2015, p. 1386). This behaviour is particularly prevalent with transport matters (Wallace et al., 2010, p. 388). Zanni et al. (2013) found that household energy savings were perceived as easier than those from transport, and there was a resistance to reduce aviation travel, while Whitmarsh (2009, p. 21) found that individuals who are trying to limit climate change rarely alter their travel behaviour.

2.3.3.3 Environmental Attitudes, Behaviours, and the NICHE PCMS

Voluntary usage of a PCMS is an example of an environmental behaviour. There is some evidence that people who believe that humans are causing climate change are more likely to participate in community-related environmental behaviours (Leviston, Greenhill, & Walker, 2015, p. 19). Howell (2012, p. 252) found that the members of the Carbon Rationing Action Groups would generally be classified as ‘positive greens’ in Defra’s environmental segmentation model, who exhibit the most pro-environmental attitudes, beliefs, and behaviour of the general public. Capstick and Lewis (2010, p. 382) found that individuals who regard themselves as environmentally concerned are more likely to support the introduction of a PCT. The pre-PCMS analysis (see Section 2.4 of this chapter) found that *Environmental Consciousness* (an individual’s attitudes towards their carbon footprint, the environment and climate change) was a significant predictor of *Usage Intentions towards a PCTS*. However, the pre-PCMS analysis measured attitudes towards a generic, hypothetical PCTS prior to the NICHE PCMS trial, and the survey respondents had no practical experience with using such a system. In addition, given the differences that were found in the literature between environmental attitudes and behaviours, support for PCT may not necessarily indicate voluntary usage of the NICHE PCMS. No literature was found on how an individual’s environmental attitudes and behaviours would influence voluntary usage of an actual PCT-like system. To the best of the author’s knowledge, the research reported in this thesis is the first study looking at whether environmental attitudes and behaviours predict voluntary PCMS usage.

2.3.4 Health and Obesity

An objective of the broader NICHE project was to examine the relationship between health and PCTS. The premise that there is a link between health and carbon emissions, and that PCT could lead to a reduction in obesity and its underlying health issues (Egger, 2008; Egger & Swinburn, 2011; Webb & Egger, 2013) was one of the rationales behind the establishment of the NICHE project. The literature described in this section explores the link between health, obesity, carbon emissions, and what impact health and obesity could have on the voluntary usage of the NICHE PCMS.

2.3.4.1 Health and Obesity Links

In developed countries, obesity has reached epidemic proportions and is also becoming a serious problem in developing countries (World Health Organisation, 2017; World Obesity Federation, 2017). The literature shows that there is a relationship between obesity and poor health. Obesity has been shown to increases the risk of a range of health problems including hypertension, dyslipidemia, diabetes, stroke, osteoarthritis, sleep apnea, coronary heart disease, and respiratory problems (U.S. Department of Health and Human Services, 2013, p. 3; Jensen et al., 2014, p. 104). Obesity also increases the risk of many cancers (Kushi et al., 2006, p. 258; Bhaskaran et al., 2014, p. 755).

2.3.4.2 Climate Change Links

In recent years, a number of researchers have speculated that there is a direct link between obesity and its underlying health issues and an individual's carbon footprint (Faergeman, 2007; Delpeuch, Maire, & Emmanuel, 2009; Edwards & Roberts, 2009; Friel et al., 2009; Egger & Swinburn, 2011; Skouteris et al., 2013; Guzman & Clapp, 2017). The primary causes of obesity are *increased calorie consumption* and *decreased calorie expenditure* (Hill et al., 2003, p. 853; Pi-Sunyer, 2003, p. 859; Caballero, 2007, p. 2; Egger, 2007, p. 185; Bleich et al., 2012, p. 4). The evidence described in this section also shows that *increased calorie consumption* and *decreased calorie expenditure* are associated with increased GHG emissions, including carbon dioxide, and climate change. Figure 2-10 shown below summarises these relationships.

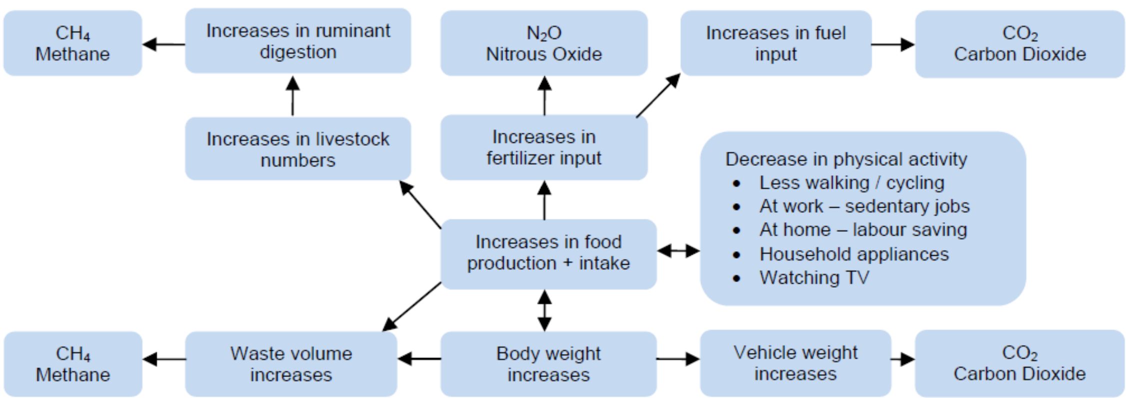

Figure 2-10 The Link Between Obesity and Climate Change (Delpeuch, Maire, & Emmanuel, 2009). Reprinted with permission.

It has been shown that diets containing an excess consumption of meat can increase the likelihood of obesity compared to mostly plant-based diets (Wang & Beydoun, 2009, p. 624; Rouhani et al., 2014, p. 1). Meat production has the largest carbon, methane, and nitrous oxide footprints of any food source, while fresh vegetables, cereals, and legumes have the lowest (Carlsson-Kanyama & González, 2009, p. 1706; Virtanen et al., 2011, p. 1852). Animal slaughtering and processing accounts for the greatest use of energy in the food industry in the United States (IPCC, 2014a, p. 761). Land requirements to produce meat and its associated feedstock has also resulted in large-scale land clearing, which has decreased the world's carbon sinks and contributes to climate change (Henning, 2011, p. 72).

Processed foods (and ultra-processed foods in particular) typically contain no wholefoods, are nutrient and fibre deficient, have a high glycaemic load, and are high in saturated fat, salt, and sugar (Moodie et al., 2013, p. 2; Canella et al., 2014, p. 2). Such foods are also positively associated with increased Body Mass Index (BMI) and obesity (Egger & Swinburn, 2011; Stuckler et al., 2012, p. 1; Moodie et al., 2013; Canella et al., 2014). Processed foods and drinks are responsible for the second-largest use of energy of any food product (Wallén, Brandt, & Wennersten, 2004, p. 527), while processing and packaging of food accounts for 21% of the energy use in the United States, equal to the energy used for all agricultural production (Hill, 2008, p. 3).

Reliance on private fossil fuel-powered transport instead of active forms of transport, i.e. walking and cycling, is a significant contributor towards a sedentary lifestyle and the obesity epidemic (Higgins & Higgins, 2005b, p. 1; Edwards & Roberts, 2009; Woodcock et al., 2009). Developed countries that have the have the highest levels of active transport have the lowest obesity rates (Bassett et al., 2008). Fossil fuel-powered transport accounts for approximately one-quarter of the world's carbon dioxide emissions and is a significant contributor towards climate change (Kahn Ribeiro et al., 2007, p. 325; Woodcock et al., 2009, p. 1930). In the United States, Higgins and Higgins (2005b, p. 2) found that, if the recommended levels of exercise in the form of cycling were adopted, instead of driving for short trips, there would be a 34.9% reduction in oil consumption. Public transportation usually has an element of active transport associated with it, thereby reducing fossil fuel usage and the associated carbon emissions (Higgins, 2005a, p. 200). The obesity epidemic itself is also a contributor towards higher fuel energy use and its associated carbon emissions on account of the increased energy required to move heavier individuals and the decreased likelihood that these individuals use forms of active transport (Edwards & Roberts, 2009, p. 1138).

2.3.4.3 Health, Obesity, and the NICHE PCMS

The literature has shown that there is a link between health, obesity, and carbon emissions. It is thought that PCT (in conjunction with a secondary policy covering the business sector for those schemes that only cover household energy use) may promote an increase in health and a reduction in obesity by discouraging the consumption of processed food products that have a high carbon footprint and promoting active transport over fossil fuel-powered transport (Egger, 2008; Egger & Swinburn, 2011; Webb & Egger, 2013). Whitmarsh (2009, p. 21) argues that highlighting the health benefits of active transport might also encourage alternatives to fossil fuel-powered transport, thereby reducing carbon emissions. The pre-PCMS analysis, discussed in the next section, found that *Self-Health Evaluation* (an individual's evaluation of their health) and *Health Consciousness* (an individual's attitude towards health and body weight) were significant predictors of *Usage Intentions towards a PCTS.* The review of the literature did not identify any other studies outside of the NICHE project that explores the direct relationship between health, body weight and PCT. The research reported in this thesis aims to fill this gap in the knowledge and identify if self-reported health, together with attitudes towards health and body weight, are significant in predicting voluntary usage of an actual system that represents several significant aspects of a PCTS.

2.3.5 Measuring PCMS Usage Summary

After reviewing the technology acceptance literature, TAM2 was identified as the most relevant model for the research. However, it was clear that not all the constructs in the TAM2 were relevant when measuring PCMS user acceptance and usage behaviour, as TAM2 was designed for information systems in a workplace setting. A review of the literature covering climate change beliefs, environmental attitudes and behaviours, health, obesity, and carbon emissions was undertaken to identify additional factors that may predict PCMS usage. While extensive research was found in these areas, there are gaps in the literature about how these attitudes and behaviours would contribute towards voluntary PCMS usage. This is discussed further in Section

2.5 when the chapter is summarised. The next section describes the pre-PCMS analysis that was undertaken on the pre-PCMS survey.

2.4 Pre-PCMS Analysis

After completion of the pre-PCMS survey, data analysis was undertaken on the pre-PCMS survey dataset and was reported in the candidates Master of Business entitled "Factors affecting the intention to use a personal carbon trading system" (Hendry, 2014). The results of the pre-PCMS analysis were also reported in other publications that the candidate was the lead author in or contributed towards (Webb et al., 2014; Hendry et al., 2015; Hendry et al., 2016). The results of the pre-PCMS analysis assisted in the design of the conceptual model (see Section 3.3.4.4) and are compared with a similar analysis of the post-PCMS dataset in Chapter 6 to examine Research Question 1 (*What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?*). The results of the pre-PCMS analysis are summarised in this section.

The survey items in the pre-PCMS survey (see Appendix B) were grouped in the following sections:

- General Information – General information about the respondent and their household, their health, and their beliefs about their own and their households' carbon footprint;

- Attitudes – The respondent and their households' attitudes towards health, the environment, carbon emissions, and climate change;
- Behaviours – The respondent and their households' behaviours towards consumption and the environment; and
- Personal Carbon Trading – The respondent's attitudes and beliefs about PCT;

Correlation analysis found a high number of significant relationships at the 99% confidence interval ($p < 0.001$) among the variables from each section of the survey. Given the number of variables, similar survey items were grouped based on the expectation that factors would emerge from the analysis of the data. Therefore, a decision was made to run exploratory factor analysis (EFA) on each block of survey items on a section by section basis to obtain the highest case-per-variable ratio, minimise the chances of overfitting the data, and avoid deriving factors that are sample-specific with little generalisability (Hair et al., 2010, p. 102).

The survey items in the 'attitudes towards health, the environment, carbon emissions, and climate change' section of the pre-PCMS survey all used scale descriptors ranging from *1 – "strongly agree"* to *7 – "strongly disagree"* with a midpoint of *4 – "neutral"*. The EFA run on this section resulted in the following three factors that explained 62.2% of the variance among the items (KMO = 0.797, $p < 0.001$) (Hendry, 2014, pp. 142-148).

The variables that loaded on the first factor were:

- B3. Being overweight can have serious health effects;

- B8. I always try to eat healthy food;
- B9. I am confident I could maintain a healthy body weight if I wanted to;
- B11. Walking or cycling instead of using the car can help to reduce a person's; weight; and
- B12. I am unlikely to ever be obese.

This factor was labelled *Health Consciousness* as these survey items measured an individual's attitude towards health and body weight.

The variables that loaded on the second factor were:

- B2. Technology will solve future environmental problems;
- B4. Obesity will be solved in the future by medical advances;
- B6. A financial incentive would encourage me to reduce my environmental impact;

This factor was labelled *Optimism* as these survey items measured an individual's attitude towards the perceived impact that technology could have in relation to improving health and environmental change.

The variables that loaded on the third factor were:

- B1. I buy environmentally friendly products as much as I can;
- B5. It is important for me to have a low carbon footprint;
- B7. Collectively, households can reduce the impacts of greenhouse gas emissions; and

- B13. I am worried about climate change.

This factor was labelled *Environmental Consciousness* as these survey items measured an individual's attitude towards the environment, their carbon footprint and climate change.

The EFA run on the 'behaviours towards consumption and the environment' section of the pre-PCMS survey resulted in a single factor that explained 47.5% of the variance among the items (KMO = 0.764, $p < 0.001$) (Hendry, 2014, pp. 148-149). This factor was labelled *Environmental Action* as these survey items, listed below, measured an individual's environmental and consumption behaviours. All six of the survey items used scale descriptors ranging from *1 – "never"* to *7 – "always"* with a midpoint of *4 – "sometimes"*.

- B14. I turn the tap off when cleaning my teeth;
- B15. I turn lights off when not in use;
- B16. I sort my rubbish;
- B17. I look to buy second hand over brand new;
- B18. I consciously try to reduce waste and recycle; and
- B19.I buy local produce, even if imported is cheaper.

The EFA run on the 'PCTS' section of the pre-PCMS survey also resulted in a single factor that explained 56.4% of the variance among the items (KMO = 0.926, $p <$ 0.001) (Hendry, 2014, pp. 150-152). This factor was labelled *Usage Intentions towards a PCTS* as these survey items, listed below, measured an individual's attitudes towards PCTS. All of the survey items had scale descriptors ranging from *1 – “strongly agree”* to *7 – “strongly disagree”* with a midpoint of *4 – “neutral”*.

- E1. Being able to measure my carbon footprint is important to me;
- E2. Most people would accept a PCT system as a tool for improving the environment;
- E3. A PCT system would encourage me to reduce my carbon footprint;
- E4. A PCT system would encourage me to walk or cycle more and drive less;
- E5. People who reduce their carbon footprint should be rewarded in some way;
- E6. People with a greater carbon footprint should have to pay for it in some way;
- E7. A PCT system would encourage me to eat more healthy, locally grown produce;
- E8. A PCT system would be useful for me to help monitor my environmental impact;
- E9. Comparing my carbon usage to the average would influence my consumption habits; and
- E10. There is a strong link between a person’s carbon footprint and their health.

The individual variables that were identified as loading on the *Health Consciousness*, *Optimism*, *Environmental Consciousness*, and *Environmental Action* factors were entered as blocks into a multiple linear regression model. The dependent variable for the model was the weighted factor score derived from the EFA that measured *Usage Intentions towards a PCTS*. The pre-PCMS survey did not contain a 'self-health evaluation' section; however, the following four survey items were included in different sections to provide a basis to measure the self-reported health of the respondent. The scales for the survey items are contained in the parentheses following the survey items.

- A9. Do you generally consider your health to be? (*poor, fair, good, very good, excellent*);
- A10. How would you best describe yourself? (*very underweight, a bit underweight, healthy weight, a bit overweight, very overweight*);
- A12. Compared to others on the island of similar age and gender do you consider your body weight to be? (*well below average, below average, about average, above average, well above average*); and
- C1. How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health? (*daily, 3–5 times a week, 1–3 times a week, less than once a week, never*).

The scales used for the 'self-health evaluation' survey items made the data unsuitable for EFA as they were categorical (see Appendix B). Nevertheless, correlation analysis found that all but one of the relationships among the variables were significant. There was also an expectation that there was a relationship between the 'self-health evaluation' survey items and *Usage Intentions towards a PCTS*. Therefore, the 'self-health evaluation' survey items were entered into the regression model as a single block that was labelled *Self-Health Evaluation*. The outputs of the regression model can be seen in Figure 2-11 below, and the significant relationships have been highlighted. The regression model shows that *Usage Intentions towards a PCTS* were predicted by *Self-Health Evaluation*, *Health Consciousness*, *Environmental Consciousness*, and *Optimism.* The *Environmental Action* block of variables was not found to be a significant predictor. Further regression analysis conducted on the pre-PCMS dataset found that *Environmental Action* was only a significant in predicting the *Usage Intentions towards a PCTS* for individuals who believed that they had a lower than average carbon footprint (Hendry, 2014, p. 169).

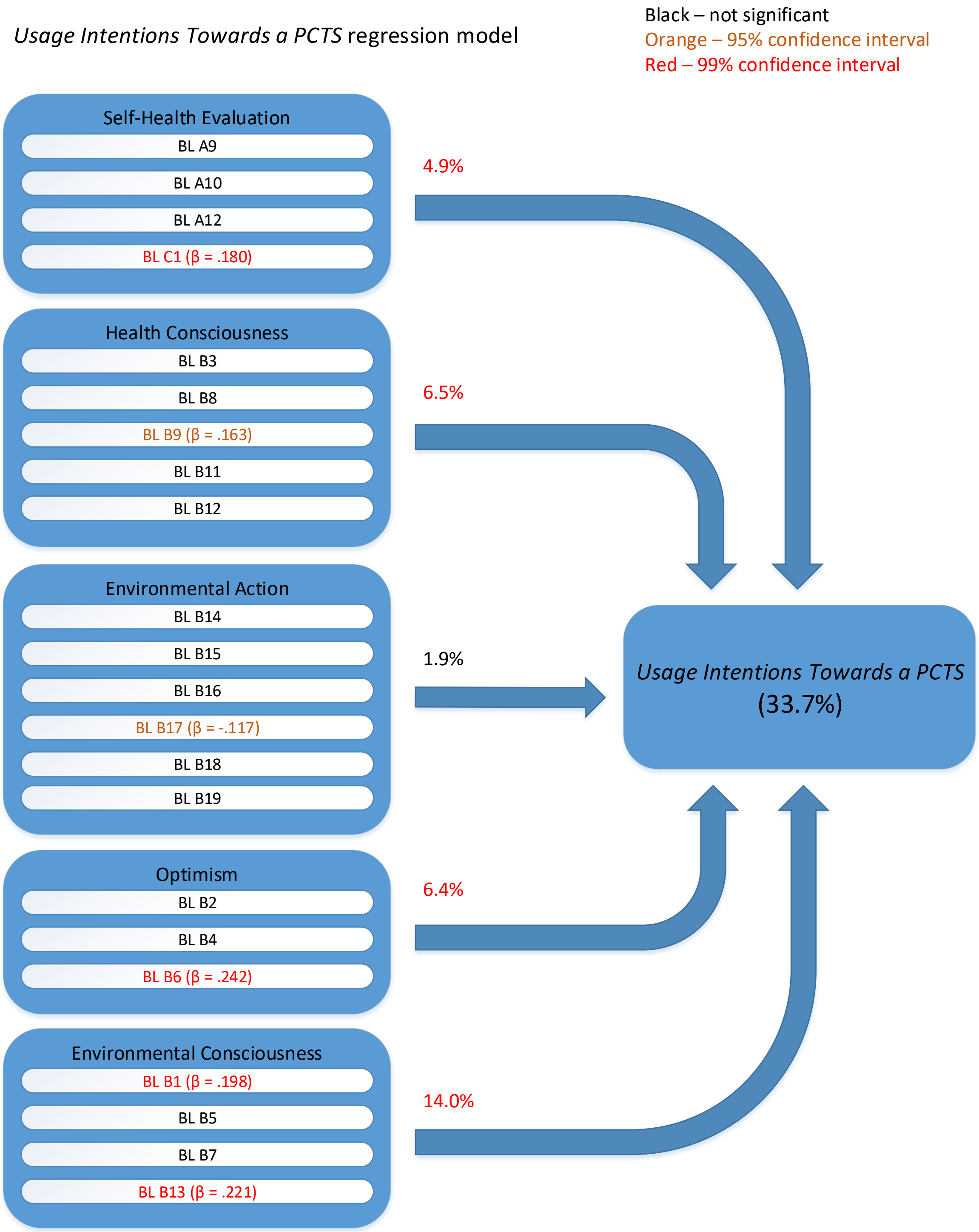

Figure 2-11 Pre-PCMS Usage Intentions towards a PCTS Regression Model

2.5 Chapter Summary

The literature reviewed in Section 2.2 highlighted that there has been considerable research into PCT from a theoretical perspective. No evidence was found of any voluntary PCTS or PCMS trials across a whole community outside of the current research, and the NICHE PCMS trial was recognised as being the first voluntary trial of its kind. The literature reviewed in Section 2.3 identified that extensive research has been conducted in the following areas:

- Technology acceptance and the factors that predict information systems usage and acceptance in a workplace setting;
- Popular perceptions of climate change, and the causes of climate change scepticism;
- The disparity between environmental attitudes and behaviours, and the 'value-action gap'; and
- The increased carbon emissions associated with behaviours that cause obesity and its underlying health issues.

No evidence was found of a technology acceptance model having been applied to a voluntary PCMS. While the relationship between levels of climate change concern and self-ascribed responsibility for climate change and support for PCT has been explored, no research was uncovered regarding how anthropogenic climate change beliefs would influence voluntary PCMS usage. The pre-PCMS analysis, described in Section 2.4, was identified as having explored:

- The link between attitudes and behaviours towards the environment and attitudes towards PCTS;
- The link between attitudes and behaviours towards health and body weight and attitudes towards PCTS; and
- The link between an individual's self-reported health and attitudes towards PCTS;

However, no research was found on how these attitudes and behaviours would predict voluntary usage of a PCMS that promotes the usage of a carbon card, the production of carbon footprint statements, and the identification of a carbon footprint target. The research presented in this thesis is intended to bridge the gaps in the literature that were identified in this chapter. In the next chapter, the methodology used for the research is described.

Chapter 3 - Methodology

3.1 Introduction

This chapter summarises the methodology used for the NICHE project and contains the following three sections:

- 3.2 NICHE Project;
- 3.3 Empirical Strategy; and
- 3.4 Overview of the Statistical Analysis.

In Section 3.2, the establishment, stakeholders, and initial stages of the NICHE project are described, followed by the design, development, promotion, and administration of the NICHE PCMS trial. Section 3.3 discusses the pre-PCMS and post-PCMS surveys, and the administration practices, sample selection, and promotional activities undertaken for both surveys. The research questions and the construction of the conceptual model that underpins the research are then described. The chapter concludes in Section 3.4 with a description of the statistical analysis procedures undertaken for the post-PCMS survey data analysis in Chapter 5.

3.2 NICHE Project

3.2.1 Establishment

The NICHE project was established to trial a PCTS and investigate its public acceptability, together with its effect on health, carbon emissions, and the environment. The project was funded by a Linkage Grant from the Australian Research Council (ARC), and ethics approval was obtained from the Human Research Ethics Committee at Southern Cross University in January 2012 (ECN-12-012). The choice of Norfolk Island was covered in Section 1.4.1 of the introductory chapter. Between 2009 and 2010, three visits to Norfolk Island were undertaken to assess its suitability for a PCT trial. At the time, Norfolk Island was administered as an external territory of Australia and had limited self-governance under the Norfolk Island Assembly (NIA), which was comprised of nine elected members (Norfolk Island has since been incorporated into the state of New South Wales, Australia). Meetings were held with the NIA, community groups and relevant stakeholders on the island. During this period, consultations with Tina Fawcett, an authority in PCT research, were undertaken. In September 2010, a formal presentation of the project was made to and subsequently accepted by the NIA.

After the acceptance of the project by the NIA, four public meetings were held to explain the aims of the research and petition community involvement. The meetings were reported in the *Norfolk Online* (Norfolk Island online news site), the *Norfolk Islander* (Norfolk Island local newspaper) and on *Radio Norfolk* (Norfolk Island's local radio station). The local administration of the project was overseen by two Norfolk Island residents who were recruited to work part-time as project officers (referred to in the following sections as NICHE project officers). A study committee comprised of six members of the community, two members of the NIA, and the two NICHE project officers was formed to provide input into the project. After consultation with the study committee, the name Norfolk Island Carbon and Health Evaluation, or NICHE, was chosen for the project. Four focus groups comprised of 8–10 residents aged over 18 years of age were undertaken to gain an understanding of the following attitudes and behaviours before the planned PCTS trial:

- Energy consumption habits (petrol, diesel, gas and electricity);
- Food consumption habits;
- Methods of transportation;
- How to advocate participation;
- Initial reactions to the project; and
- Any concerns about the collection of data.

3.2.2 NICHE PCMS Design and Development

After the establishment of the NICHE project, the existing infrastructure on Norfolk Island was investigated to determine how best to develop and trial the proposed PCTS. Discussions were held in mainland Australia with the head offices of the Westpac Bank and the Commonwealth Bank (the two major banks on Norfolk Island) in an effort to obtain their support to develop a carbon bank and use their EFTPOS (electronic funds transfer point of sale) infrastructure to record transactions. Both banks declined to be involved in the project, with both claiming that it did not align with their core business. A third party that was approached (Bartercard) resulted in the same outcome. Given the lack of support from the banks and the fact that the retailers on the island all used different Point of Sale (POS) software, integration with any of the existing electronic infrastructure on the island was deemed impossible.

At this time, it became apparent that it would not be possible to implement the trading component of a PCTS (see Section 3.2.4). Therefore, it was decided to develop a standalone carbon emissions monitoring system based on the other significant components that were included in all of the most well-developed conceptual downstream PCT schemes identified in the review of the PCT literature. These components included the usage of a carbon card, the production of carbon statements, and the identification of a carbon emissions reduction target for users of the system. The resulting NICHE PCMS was designed and developed by the author of this thesis and tracked the carbon emissions on selected fossil fuel-based products (petrol, diesel, electricity and gas) at a household level from March 2013 until the end of June 2014. A comprehensive overview of the NICHE PCMS is provided in Section 3.2.4 of this chapter.

3.2.3 NICHE PCMS Promotion and Registration

While all of the proposed PCT schemes are designed to be mandatory, this was unacceptable politically and ethically for the NICHE PCMS trial. As a result, households were required to register to participate in the trial. Registration involved a member of the household over the age of 18 signing a consent form and a release of information form to allow access to their data from the utility companies. The household was then assigned a unique identification number, and a NICHE carbon card (similar to an ID card or shopping loyalty card) was provided for each adult residing in the household. As an incentive, participating households received a 4 cent a litre discount on petrol and diesel purchases, while the petrol stations received a 1 cent a litre bonus that was funded by the NICHE project. While it may seem counter-intuitive for a project communicating the importance of carbon and energy savings to offer a discount on petrol and diesel purchases, it was essential for participating households to use their carbon card when purchasing these products so that the resulting carbon emissions could be tracked. More environmentally friendly 'green' rewards were considered. However, none could guarantee compliance, and a discount for these products was recommended by the study committee and focus groups on Norfolk Island (see Section 3.2.1) as the most useful incentive to attract households to participate in the trial. In total, 219 households registered to take part in the NICHE PCMS trial.

Invitations to register were mailed to all occupied households, and the following promotions were undertaken by the NICHE project officers on Norfolk Island to encourage participation:

- In July/August of 2012, a competition was held at the Norfolk Island Central School for the Year 9 and 10 Graphic Design students to design the artwork used for the NICHE carbon card;
- In October 2012, the NICHE project officers held a stall at the Royal Agriculture and Horticultural Show Sustainability Tent to promote the NICHE PCMS;
- In January 2013, a mail-out to all houses on the island was undertaken to encourage people to register for the NICHE PCMS trial;
- In the last quarter of 2012 and the first quarter of 2013, advertisements and articles were published in the *Norfolk Islander* and *Norfolk Online*;
- Posters and brochures were displayed in prominent positions around the island in the lead up to registration times;
- A promotion was run on the NICHE website and the NICHE Facebook page; and
- Promotions and interviews with NICHE researchers, including the author of this thesis, were conducted on *Radio Norfolk.*

Registrations were open to all households on the island from the 11th to the 16th of February 2013. Households that registered during this period started using the NICHE PCMS in March 2013 and were part of an initial trial period to test the system.

Registrations were open again from 18th to 30th April 2013 to encourage more involvement among the population of the island. Registration packs were available from selected outlets on Norfolk Island, including the Norfolk Mall, the Post Office, Telecom, Admin Accounts, and the island's three petrol stations. Registration packs were also available for download from the NICHE website. Ballot Boxes and an information desk were set up in the Norfolk Mall during the two registration periods for potential participants to submit their completed registration forms. The ballot boxes and information desk were staffed by the NICHE project officers during the registration periods to help complete the forms and answer any questions that potential participants might have. During the registration period, NICHE project officers were also available for home visits to help potential participants to fill out their registration pack if they were unable to attend the information desk at Norfolk Mall.

3.2.4 NICHE PCMS Administration

The NICHE PCMS was a web-based system with the following components:

- A custom POS system;
- A central server and database;
- A system administration website; and
- An end-user website.

The three petrol stations on Norfolk Island were all fitted with the custom POS terminals that allowed PCMS users to enter their household's identification number or scan their NICHE carbon card to record their transactions and receive their discount. The POS uploaded their petrol and diesel sales into the NICHE database. Sales data for natural gas and electricity (provided by a local diesel power station) were provided by the utility companies for participating households and uploaded into the NICHE database by way of a custom web service. Software running on the NICHE server calculated the carbon emissions associated with these products and services based on the predetermined carbon values measured in kilograms of carbon dioxide (kg CO_2) listed below. The School of Physics at the University of Sydney calculated these values relative to Norfolk Island, with transportation taken into consideration.

- 1 litre petrol = 2.38 kg CO_2;
- 1 litre diesel = 2.70 kg CO_2;
- 1 kg gas = 2.90 kg CO_2; and
- 1 kWh electricity = 0.75 kg CO_2.

At the start of the trial, households were categorised by the number of occupants. There were five household categories: one, two, three, four, and five-member households, respectively. After collecting six months of baseline carbon emissions data (April to September 2013), the average carbon emissions for each household category was calculated. To account for a few identified outliers, and to provide a larger sample size and a more realistic average, households with more than four members were grouped together when calculating the average. Based on the fuel purchasing habits that were identified in the pre-PCMS survey, any household that did not purchase fuel (diesel or petrol) in any given month during the baseline carbon emissions data collection phase was deemed to be non-compliant and excluded when calculating the average. As a full year of baseline data was not able to be captured owing to the duration of the trial, the average for each household category was doubled to estimate annual household carbon emissions. It was felt that this was acceptable as there is only a six-degree variation in temperature between winter and summer on Norfolk Island and the local focus groups conducted prior to the trial reported that there was little demand for energy-intensive heating and cooling given the subtropical climate (Webb, 2018, p. 58).

Owing to the lack of support in using the local banking infrastructure, it was not possible to implement tradable carbon allowances. To simulate the carbon allowances provided in all the proposed PCT schemes identified in the literature, a suggested non-compulsory carbon allowance (referred to as a reduction target in this thesis) that was 10% lower than the baseline average was introduced for each household category following the baseline data collection period. The quarterly baseline carbon emissions average (annual emissions divided by four) and the quarterly reduction target for each household category are shown in Table 3-1 below. The quarterly reduction target was provided to households in their quarterly carbon emission statements and via the NICHE end-users website (described at the end of this section) for the remainder of the trial (October 2013 to June 2014).

Number of Household Members	Quarterly Baseline Household Carbon Emissions (kg CO_2)	Quarterly Reduction Target (kg CO_2)
1	633	575
2	1012	920
3	1183	1075
4 and 5	1249	1135

Table 3-1 Average Baseline Carbon Emissions and Reduction Target for each Household Category

Children are not normally provided a carbon allocation equal to adults in any of the proposed PCT schemes (Starkey, 2012). However, if households were further categorised by the number of children in each household (or any other criteria), the sample size of each household category would not allow the calculation of an accurate average and carbon reduction target, and the ability for comparisons between households would have been limited. It is recognised that this is a limitation of the study. It is also recognised that, in all of the proposed PCT schemes, adults are given an equal per capita carbon allowance as opposed to calculating carbon allowances based on the household size as described above.

Table 3-2 below shows the quarterly baseline carbon emissions for the compliant households that had the highest and lowest emissions in each household category. The percentage of compliant households in each household category that had quarterly baseline carbon emissions above and below the reduction target, along with the average quarterly carbon emissions for those compliant households above and below the reduction target is also provided.

Number of Household Members	Highest Quarterly Baseline Household Carbon Emissions (kg CO_2)	Percentage of Households Above the Target	Average Quarterly Baseline Carbon Emissions (kg CO_2) for Households Above the Target
1	1103	54%	766
2	1959	54%	1258
3	1993	61%	1464
4 and 5	2756	56%	1609
Number of Household Members	**Lowest Quarterly Baseline Household Carbon Emissions (kg CO_2)**	**Percentage of Households Below the Target**	**Average Quarterly Baseline Carbon Emissions (kg CO_2) for Households Below the Target**
1	227	46%	413
2	216	46%	703
3	430	39%	673
4 and 5	581	44%	858

Table 3-2 Quarterly Baseline Carbon Emissions Above and Below the Reduction Target

For the duration of the trial, households could view their carbon emissions in real-time on the end-user website (see Appendix E). The NICHE PCMS generated and emailed carbon usage statements (see Appendix D) to all households at the end of each quarter (April–June 2013, July–September 2013 and October–December 2013, January–March 2014, April–June 2014). Households without an email address received a hard copy of their statement via surface mail. The end-user website and the carbon usage statements provided a breakdown of the household's carbon emissions and a series of charts to show household members how their carbon emissions for that quarter ranked against:

- Previous quarters;
- The average carbon emissions of other households in the same category (same number of occupants); and
- The carbon reduction target for their household category.

3.3 Empirical Strategy

3.3.1 Survey Overview and Administration

The effects of the NICHE PCMS trial were to be assessed by comparing pre and post attitudes, behaviours, and measures across a range of areas. On account of the multidisciplinary nature of the project and the health component, mixed methods were used based on the World Health Organization's (WHO) 'STEPwise' approach (World Health Organization, 2008) as follows:

- Step 1 – A survey of households on Norfolk Island;
- Step 2 – Anthropometric measures of a sample of the Step 1 participants; and
- Step 3 – A study of the movement levels over three days of a sample of Step 2 participants.

Steps 1–3 were carried out before the NICHE PCMS trial and were repeated following the NICHE PCMS trial. Steps 2 and 3 were only relevant to the research conducted by the School of Health and Human Sciences and are not discussed further as they are outside of the scope of the research conducted in this thesis.

The purpose of the pre-PCMS survey (Step 1 – before the NICHE PCMS trial [see Appendix B]) was to gather preliminary data on individual and household attitudes and behaviours in order to evaluate the impact of the NICHE PCMS trial. The multi-disciplinary nature of the NICHE project was reflected in the design and construction of the pre-PCMS survey and included the following sections:

- General information – General information about the respondent and their household, their health and their beliefs about their own and their household's carbon footprint;
- Attitudes – The respondent and their household's attitudes towards health, the environment, carbon emissions and climate change;
- Behaviours – The respondent and their household's behaviours towards consumption and the environment;
- Physical activity – The respondent and their household's physical activity;
- Nutrition – The respondent's diet and nutrition;
- Personal carbon trading – The respondent's attitudes and beliefs about PCT; and
- Demographic data – The respondent and their household's demographic data.

The post-PCMS survey (Step 1 – following the NICHE PCMS trial [see Appendix C]) contained the same survey items as the pre-PCMS survey; however, some of the survey items in the 'Personal Carbon Trading' section were re-phrased in the post-PCMS survey to gather data specific to the NICHE PCMS as opposed to a generic

PCTS. An additional section was included in the post-PCMS survey to gather data about the usability, impact, usage, and acceptance of the NICHE PCMS.

Where possible, the survey items in both surveys were derived from existing research or influenced by other surveys and were re-phrased to reflect the needs of the NICHE project. All survey participants answered the survey items in the pre-PCMS survey. In the post-PCMS survey, some of the survey items relating to the usability, impact, usage, and acceptance of the NICHE PCMS were only answered by PCMS users as these survey items were only pertinent for survey participants who had participated in the NICHE PCMS trial. Given the nature of the broader NICHE project, not all the survey items were relevant to the research covered in this thesis. In Appendix A**,** a list of the survey items that were relevant to the research is provided that includes:

- The survey item identifiers for the pre-PCMS and post-PCMS survey items as these changed for some of the survey items in the post-PCMS survey;
- The difference in wording for those questions that were re-phrased in the post-PCMS survey;
- The additional survey items in the post-PCMS survey; and
- Identification of the survey items that were only answered by PCMS users in the post-PCMS survey.

Following the construction of the pre-PCMS survey, a focus group comprising of 20 women and men between the ages of 12 and 86 was assembled to provide feedback and evaluate the likely performance of the survey as a research instrument. While the surveys were only open to residents of Norfolk Island over the age of 18, younger individuals were included to make sure that the survey items were easily understood. The outcomes of the focus group were covered in the candidate's Master of Business thesis (Hendry, 2014, pp. 82-87). An examination of the pre-PCMS survey was also undertaken by the 2011 Norfolk Island census field supervisor. The additional questions in the post-PCMS survey were evaluated by the NICHE project officers and other academics and researchers at Southern Cross University in order to assess their suitability for inclusion.

At the start of the project, a decision was made to use paper-based surveys rather than conducting the survey online for the following reasons:

- Not all residents had access to the internet;
- Internet speeds on Norfolk Island were not always reliable in 2012 when the pre-PCMS survey was conducted;
- The 2011 Norfolk Island census was paper-based, which meant that the same guidelines and administration practices could be used; and
- The NICHE study committee and the focus groups established at the start of the project had recommended this method.

In early March 2012, before the NICHE PCMS trial, a copy of the pre-PCMS survey was hand-delivered to each household on Norfolk Island as identified in the 2011 Norfolk Island census. Households had until Monday the 26th of March 2012 to complete the pre-PCMS survey. Completed surveys could be returned to a designated drop off location at the Norfolk Shopping Mall or the Post Office, or the surveys could be picked up by a NICHE project officer if required.

After the NICHE PCMS trial, a copy of the post-PCMS survey was mailed to all households on the island on the 29th of September 2014. Households had until Friday the 17th of October 2014 to return their surveys. Once again, completed surveys could be returned to the Norfolk Shopping Mall or the Post Office, or could be picked up by a NICHE project officer if required.

Given the amount of personal information collected, the NICHE study committee, the focus groups established at the start of the project, and the focus group that examined the pre-PCMS survey felt that most residents would not participate in the survey if identifying information was required. As a result, the pre-PCMS and post-PCMS surveys were confidential and contained no data that could be used to identify the respondent. While this was done to increase participation, it did introduce some limitations that are discussed in Section 7.4 of the concluding chapter. A data entry program was developed by the author of this thesis to convert the paper-based surveys to an electronic format that assigned a unique ID number to the survey and the corresponding electronic copy in case of data entry errors. As part of a quality control process, one survey in every ten was checked against the electronic copy. The paper surveys were archived on completion.

3.3.2 Survey Sample Selection

The pre-PCMS and post-PCMS surveys used similar sample selections. All households on Norfolk Island were invited to participate in the pre-PCMS and post-PCMS surveys, and the surveys were open to any permanent resident of Norfolk

Island or long-term temporary resident over the age of 18 years. Owing to the multidisciplinary nature of the NICHE project, the surveys were administered to gather both *individual* and *household* data. As a result, it was requested that only *one* member of each household complete the survey. It is recognised that the attitudinal items in the surveys reflect the views of that individual and may not be shared by other members of the household. It is also understood that, while this was done to fit the requirements of the project, it limited the potential number of responses.

It was essential to have a sample selection that was representative of the population of Norfolk Island, as opposed to a subsection. To enable this, it was requested that the adult in the household whose birthday was closest to the first of any month complete the pre-PCMS survey. For the post-PCMS survey, if the household participated in the NICHE trial, it was requested that the adult who was most familiar with the NICHE PCMS and its accompanying carbon statements complete the survey. If the household did not participate in the NICHE PCMS trial, the same guidelines used for the pre-PCMS survey were followed. The sample sizes of each survey are discussed in Section 4.2.1.

3.3.3 Survey Promotion

The pre-PCMS and post-PCMS surveys had similar publicity campaigns that were run in the six weeks prior to each of the surveys being administered. The publicity campaigns included the following activities:

- Advertisements and articles were published in *Norfolk Online* and the *Norfolk Islander*;
- Interviews with the local NICHE project officers and advertisements were aired on *Radio Norfolk*;
- Posters were displayed in prominent positions around the island;
- An email campaign was undertaken using a mailing list that had been assembled from previous publicity drives and, in the case of the post-PCMS survey, the NICHE PCMS trial and the pre-PCMS survey; and
- A promotion was conducted on the NICHE website and the NICHE Facebook page.

Section 8 of the *Census and Statistics Act 1961* defines six census districts on Norfolk Island, as shown in Figure 3-1 below:

Figure 3-1 Norfolk Island Census Districts

As a part of the publicity campaign, a lottery was held on *Radio Norfolk* to choose six local community groups before the pre-PCMS and post-PCMS surveys were administered. Each of the chosen community groups was assigned a census district. For every returned survey in that district, the community group received a donation. A total of A$8,000 (funded by the NICHE project) was budgeted for the donations for each of the surveys. Each district was assigned $1,000, which was divided by the number of households in the district to calculate a donation amount per returned survey. The money that was leftover was awarded as a prize to the community group that had the highest proportion of returned surveys.

3.3.4 Research Questions, and the Conceptual Model

The following sections discuss the pre-PCMS and post-PCMS surveys as they pertain to the three research questions and the proposed conceptual model. The construction and origin of the survey items that were included in both surveys was discussed in the candidate's Master of Business thesis (Hendry, 2014, pp. 77-81) and is not covered in this thesis. The construction and origin of the new post-PCMS survey items are discussed in Section 3.3.4.4 below.

3.3.4.1 Demographics and General Information

The pre-PCMS and post-PCMS surveys included identical survey items to gather general and demographic data about the respondent, including gender, age, residential status, household makeup, education, income, health, weight, and self-assessed carbon footprint. The wording of these questions can be seen in Section 4.2 when the responses to these survey items are used to categorise and compare the surveys. Where possible, the responses to these survey items are also compared to the results of the 2011 Norfolk Island Census and the 2016 Australian Census to confirm that the survey samples were representative of the population of the island.

3.3.4.2 Research Question 1

To examine Research Question 1 (*What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?*), a comparison of responses from the pre-PCMS and post-PCMS surveys to a selection of attitudinal and behavioural survey items is undertaken in Sections 4.2 and 4.3 to identify any differences following the NICHE PCMS trial. In Section 5.4.1, the pre-PCMS analysis is compared to similar data analysis that was conducted on the post-PCMS dataset to identify any changes in the predictors of attitudes towards PCT following the NICHE PCMS trial. Due to the anonymous nature of both surveys (see Section 3.3.1), it was not possible to compare the pre and post attitudes for PCMS users and non-PCMS users. Therefore, the analysis that was conducted to explore the changes following the NICHE PCMS trial is based on the survey items that were included in *both* surveys and answered by *all* post-PCMS survey respondents in the post-PCMS survey (see Appendix A).

3.3.4.3 Research Question 2

To examine Research Question 2 (*What differences in attitudes towards PCTS will be evident between those who volunteered for the NICHE PCMS trial and those who did not?*), responses from the post-PCMS survey to a selection of attitudinal and behavioural survey items for PCMS users and non-PCMS users are compared in

Sections 4.4 and 4.5 to identify any differences between the groups. Analysis of the post-PCMS dataset, using the statistical techniques described in Section 3.4 of this chapter, is undertaken in Section 5.4.2 to examine the differences in the predictors of attitudes towards PCT for PCMS users and non-PCMS users. The analysis for PCMS users and non-PCMS users is based on the post-PCMS survey items that were answered by *all* post-PCMS survey respondents (see Appendix A).

3.3.4.4 Research Question 3 and the Conceptual Model

To examine Research Question 3 (*What factors influenced the usage behaviour of the NICHE PCMS?*), a conceptual model was developed by modifying and extending TAM2, with additional constructs identified in the literature and the pre-PCMS analysis. While some of the constructs in TAM2 are information system generic, others were designed to measure specific aspects of job functions, workplace activities and employee characteristics related to their engagement with an information system in a business context. Therefore, not all the constructs in TAM2 were relevant when measuring the usage of the NICHE PCMS. The constructs from TAM2 included in the proposed conceptual model were *Usage Behaviour*, *Perceived Usefulness*, *Perceived Ease of Use*, *Intention to Use*, *Voluntariness*, and *Subjective Norm*. The constructs not retained were *Experience*, *Image*, *Job Relevance*, *Output Quality*, and *Result Demonstrability*.

The review of the literature showed that attitudes and behaviours towards carbon emissions, climate change, the environment, health, and body weight should be considered when examining PCMS usage. This was confirmed by the pre-PCMS analysis that showed *Self-Health Evaluation*, *Health Consciousness*, and *Environmental Consciousness* were significant predictors of the *Usage Intentions towards a PCTS*, warranting their inclusion in the proposed conceptual model. *Optimism* was also found to be a significant predictor of *Usage Intentions towards a PCTS* in the pre-PCMS analysis. The survey items included as measures of this construct were based on similar survey items from the simulated PCT research conducted by Capstick and Lewis (2009) that assessed how individuals might budget their allocated carbon allowances over time and purchase additional allowances if needed. As a result, *Optimism* (renamed to *Technological Optimism*) was included in the proposed conceptual model.

In the pre-PCMS analysis, *Environmental Action* was only found to be a significant predictor of *Usage Intentions towards a PCTS* in for individuals who believed that they had a lower than average carbon footprint (Hendry, 2014, p. 169). It was expected that *Environmental Action* would be a significant predictor of the *Usage Intentions towards a PCTS* for the whole population as it was surmised that individuals who display positive environmental actions might also have positive attitudes towards PCT. At the time, it was thought that the non-significance of *Environmental Action* for the whole population might be due to the value-action gap or the pro-environmental attitudes of the vast majority of Norfolk Islanders for economic reasons, regardless of their PCT attitudes, given that fossil fuels and other products are far more expensive than on the Australian mainland (Hendry, 2014, p. 194; Hendry et al., 2015). Given the differences in the expectations of NICHE researchers and the results of the pre-PCMS analysis, *Environmental Action* was also included in the proposed conceptual model to see if this relationship has changed following the NICHE PCMS trial.

The final construct included in the proposed conceptual model was *Cost*. All the proposed PCT schemes identified in the literature recommend that individuals periodically receive carbon allowances that are tradable to meet the requirements of above-average and below-average carbon emitters (Roberts & Thumim, 2006, p. 4; Parag & Eyre, 2010, p. 354; Fawcett & Parag, 2010a, p. 332; Fawcett, 2012, p. 283). This would result in a cost for individuals with a high carbon footprint due to the additional allowances they would be required to purchase, or conversely a reward for individuals with a low carbon footprint through the sale of their unused allowances. The definitions for all the constructs in the proposed conceptual model are listed below, and the proposed conceptual model is shown in Figure 3-2, following the construct definitions.

- *Usage Behaviour* – An individual's usage and acceptance of a system;
- *Perceived Usefulness* – The degree to which an individual believes that using the system would be useful;
- *Perceived Ease of Use* – The degree to which an individual believes that using the system would be free of effort;
- *Intention to Use* – An individual's intention to use the system;
- *Voluntariness* – The extent to which an individual perceives system use to be non-mandatory;

- *Subjective Norm* – An individual's perception that most people who are important to them think they should or should not use the system;
- *Self-Health Evaluation* – An individual's evaluation of their health;
- *Health Consciousness* – An individual's attitude towards health and body weight;
- *Environmental Action* – An individual's environmental and consumption behaviours;
- *Environmental Consciousness* – An individual's attitude towards the environment, their carbon footprint, and climate change;
- *Technological Optimism* – An individual's attitude towards the perceived impact that technology could have in relation to improving health and environmental change; and
- *Cost* – The monetary cost or reward of the system to the end-user.

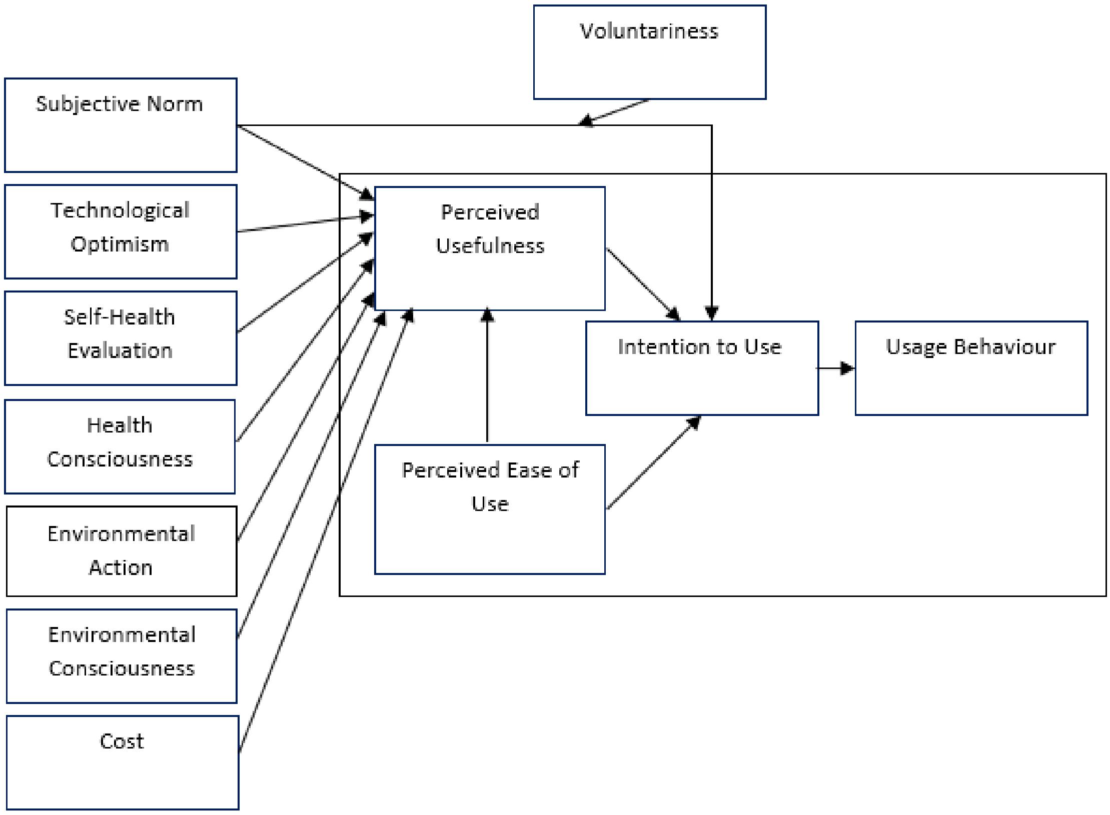

Figure 3-2 Usage Behaviour of the NICHE PCMS Conceptual Model

The survey items that loaded on the *Self-Health Evaluation*, *Health Consciousness*, *Environmental Action*, *Environmental Consciousness*, and *Technological Optimism* constructs in the pre-PCMS analysis were all included in the post-PCMS survey. Where possible, these survey items were derived from existing research or influenced by other surveys and were re-phrased to reflect the needs of the NICHE project. These survey items and their scale descriptors were listed in Section 2.4 when the pre-PCMS analysis was described. The construction and origin of these survey items were discussed in the candidate's Master of Business thesis (Hendry, 2014, pp. 77-81) and is not covered in this thesis. The survey items that are used to gather data about the remaining constructs in the proposed conceptual model are listed below. As the survey items that are used to gather data about the constructs identified in the technology acceptance literature are new in the post-PCMS survey and were influenced by existing survey items and re-phrased to reflect the needs of the NICHE project, the construction and origin of these survey items is described. All of the survey items listed below had scale descriptors ranging from *1 – "strongly agree"* to *7 – "strongly disagree"* with a midpoint of *4 – "neutral"*.

Cost

- F7. People who reduce their carbon footprint should be rewarded in some way; and
- F4. People with a greater carbon footprint should have to pay for it in some way.

In the post-PCMS survey, these survey items were answered by all survey participants.

Subjective Norm

- F2. I was encouraged to use the NICHE carbon card system by my household;
- F3. I was encouraged to use the NICHE carbon card system by the petrol station operators; and
- F4. There was pressure from the community to use the NICHE carbon card system.

In the post-PCMS survey, these survey items were answered by all survey participants, and were influenced by the following two survey items from the TAM2 and TAM3 literature that were used to measure *Subjective Norm* (Venkatesh & Davis, 2000, p. 201; Venkatesh & Bala, 2008, pp. 313-314):

- People who influence my behaviour think that I should use the system; and
- People who are important to me think I should use the system.

Perceived Usefulness

- F14. It has been a valuable use of my time to review the size of my household's carbon footprint;
- F15. Being able to review information about the size of my carbon footprint has saved me money; and
- F16. The information about my household's carbon footprint provided by the NICHE carbon card system was very useful.

In the post-PCMS survey, these survey items were only answered by PCMS users as they are related to the usage of the NICHE PCMS. These survey items were influenced by the following four survey items from the TAM2 and TAM3 literature that were used to measure *Perceived Usefulness* (Venkatesh & Davis, 2000, p. 201; Venkatesh & Bala, 2008, pp. 313-314):

- Using the system improves my performance in my job;
- Using the system in my job increases my productivity;
- Using the system enhances my effectiveness in my job; and

- I find the system to be useful in my job.

Perceived Ease of Use

- F13. It was easy to use the NICHE carbon card at the petrol station.

In the post-PCMS survey, this survey item was only answered by PCMS users as it is related to the usage of the NICHE PCMS. This survey item was influenced by the following two survey items from the TAM2 and TAM3 literature that were used to measure *Perceived Ease of Use* (Venkatesh & Davis, 2000, p. 201; Venkatesh & Bala, 2008, pp. 313-314):

- I find the system to be easy to use; and
- I find it easy to get the system to do what I want it to.

Intention to Use

- F23. If it was still available, I would continue to use the NICHE carbon card system to monitor my personal carbon footprint.

In the post-PCMS survey, this survey item was only answered by PCMS users as it is related to the usage of the NICHE PCMS. This survey item was influenced by the following two survey items from the TAM2 and TAM3 literature that were used to measure *Intention to Use* (Venkatesh & Davis, 2000, p. 201; Venkatesh & Bala, 2008, pp. 313-314):

- Assuming I have access to the system, I intend to use it; and

- Given that I have access to the system, I predict that I would use it.

Voluntariness

- F6. It should be compulsory for people to monitor the size of their carbon footprint; and
- F9. I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island.

In the post-PCMS survey, these survey items were answered by all survey participants, and were influenced by the following two survey items from the TAM2 and TAM3 literature that were used to measure *Voluntariness* (Venkatesh & Davis, 2000, p. 201; Venkatesh & Bala, 2008, pp. 313-314):

- My use of the system is voluntary; and
- Although it might be helpful, using the system is certainly not compulsory in my job.

Usage Behaviour of the NICHE PCMS

- F17. Using the NICHE carbon card system has made me more aware of my carbon footprint; and
- F18. The NICHE carbon card system has encouraged me to reduce my carbon footprint;
- F19. The NICHE carbon card system has encouraged me to walk or cycle more and drive less;

- F20. The NICHE carbon card system has helped me to monitor my environmental impact;
- F21. Comparing my household's carbon usage to the NICHE household average influenced my consumption habits;
- F22. Comparing my household's carbon usage to the NICHE Target influenced my consumption habits.

In the post-PCMS survey, these survey items were only answered by PCMS users as they are related to the usage of the NICHE PCMS.

3.4 Overview of the Statistical Analysis

This section provides an overview of the statistical analysis techniques undertaken on the post-PCMS survey using IBM's SPSS Statistics 22 software package. Statistical significance was set at the alpha level of $p = 0.05$ for all the analyses described in the following sections. The steps taken to perform the analysis were as follows:

1. Data preparation;
    a. Check for missing values;
    b. Check for outliers;
    c. Check for disengaged responses; and
    d. Normality tests.
2. Mann-Whitney U tests;
3. Correlation analysis;

4. Exploratory factor analysis (EFA); and
5. Multiple linear regression analysis.

3.4.1 Mann-Whitney U tests

A Mann-Whitney U test is a rank-based nonparametric test that is used to determine if differences exist between two groups on an ordinal or continuous dependent variable. Mann-Whitney U tests were used instead of independent-samples t-tests as not all of the attitudinal data from the surveys was normally distributed (see Section 5.2.4), and the Likert-type scales used to measure the responses were ordinal.

3.4.2 Correlation Analysis

Pearson product-moment correlations were used to determine the direction and strength of the relationships between key variables. The test generates a Pearson correlation coefficient that ranges from -1, indicating a perfect negative linear relationship, to +1, indicating a perfect positive linear relationship. A value of 0 indicates that the variables have no relationship. All correlation analysis described in this thesis are Pearson's correlations. Pearson's correlations were chosen over Kendall's tau-b or Spearman correlations as the survey data is quantitative (SPSS Inc, 2009). In all cases, a two-tailed test of significance was used as the direction of association was not known in advance (SPSS Inc, 2009).

3.4.3 Exploratory Factor Analysis

EFA is a statistical method that identifies the underlying relationships between a complex dataset, narrowing it down into a smaller set of summary variables (Hair et al., 2010, p. 99; Norris & Lecavalier, 2010) that explain most of the variance observed in the original dataset (SPSS Inc, 2009). Confirmatory factor analysis (CFA) is used when there are clear expectations about which manifest variables should load onto which factors, or when a previous model is being validated. EFA is suitable when there is less certainty about the factor structure (Smart, 2009, p. 138; Norris & Lecavalier, 2010, p. 8). On account of the exploratory nature of the research, EFA was chosen instead of CFA. Principal axis factoring (PAF) was used for factor extraction as it accounts for co-variation (Hair et al., 2010; Norris & Lecavalier, 2010).

Before a researcher undertakes EFA, two assumptions must be tested to assess the suitability of the data for factor analysis (Hair et al., 2010). These are the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity, both of which are discussed below. All the EFA reported in this thesis used the KMO and Bartlett's test of sphericity to assess the suitability of the data for factor analysis.

3.4.3.1 Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy

The KMO is a measure of the linear relationship among variables. The test generates a value ranging between 0 and 1. A value of greater than 0.5 is the minimum for sampling adequacy (Lund, 2018). All of the EFA reported in this thesis had a KMO greater than 0.5.

3.4.3.2 Bartlett's Test of Sphericity

Bartlett's test of sphericity assesses the null hypothesis that the correlation matrix among the variables is an identity matrix, which would indicate that the variables are unsuitable for EFA as they are unrelated. If the significance value generated by the test is less than 0.05, the test is statistically significant, and the data is suitable for factor analysis (Lund, 2018). Bartlett's test of sphericity was significant for all of the EFA reported in this thesis.

3.4.4 Linear Regression Analysis

Linear regression analysis is a dependence technique used to analyse the relationship between an independent variable or variables and a single dependent variable (Hair et al., 2010, p. 155). Simple linear regression analysis uses a single independent variable to predict the value of the dependent variable, while multiple linear regression analysis uses two or more independent variables to predict the value of the dependent variable. Multiple linear regression analysis provides the additional benefit of comparing the predictive power of each variant in the model (Hair et al., 2010, p. 169).

The pre-PCMS analysis used multiple linear regression analysis. To allow a comparison and examine Research Question 1 (*What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?*), the post-PCMS analysis also used multiple linear regression analysis to identify any changes following the NICHE PCMS trial. As the proposed conceptual model for the research was based on TAM2, and Structural Equation Modelling (SEM) was and is used for the statistical analysis of TAM2, it was the intention of the current research to use SEM to test the conceptual model. However, a single model could not be resolved with appropriate 'fit' as the sample size of the post-PCMS dataset for PCMS users (N = 88) was not large enough. Sample sizes of less than 100 are untenable unless a very simple model is evaluated, and sample sizes of between 100 and 200 are regarded as a better minimum (Kline, 1998, p. 12). Therefore, the analysis of the proposed conceptual model was undertaken using separate regression models that reflected the dependencies among variables, albeit as separate models rather than a single SEM.

In all of the regression models, factor scores have been calculated and used for the dependent variables. This has been undertaken as the variable groupings were statistically verified, and the EFA resulted in robust factors (see Sections 2.4 and 5.3). That a factor represents a group of variables shown to measure similar dimensions of a statistical construct means that the model is examining the relationships of groups of independent variables to a single variable represented by a factor score. The other option would have been to test separate models for each variable that comprised the factors comprising the dependent variables. This approach has shown little differentiation between model outcomes and would not have contributed to the discussion around the models other than multiple reinforcement of the same findings.

Before conducting a linear regression analysis, several assumptions need to be tested. Each of the regression models reported in Chapter 5 underwent the following tests to assess the suitability of the data for linear regression analysis.

3.4.4.1 Linearity

Linearity is the assumption that the dependent variable and the independent variables have a linear relationship. Each of the independent variables used in the regression analysis were plotted against their corresponding dependent variable. Visual inspection of the resulting scatterplots indicated a linear relationship between the variables in all regression models. The scatterplots are provided in Appendix G – Appendix Q.

3.4.4.2 Independence of Observations

An essential assumption of linear regression analysis is that the errors are independent. The Durbin Watson statistic is a test that is used to detect the independence of errors/residuals and return a value that ranges from 0 to 4. A value of close to 2 indicates that there is no correlation between residuals (Field, 2013; Lund, 2018). A range of 1.5 to 2.5 is relatively standard. A value outside of this range may be cause for concern, and values less than one or greater than three are a definite cause for concern (Field, 2013). All regression models were tested using the Durban Watson statistic. In all cases, there was an independence of residuals.

3.4.4.3 Significant Outliers

The post-PCMS dataset was checked for outliers in the data preparation stage before analysis (see Section 5.2.2) and via the visual checks of the scatterplots in the test of linearity. A case-wise diagnostics table was generated to confirm the absence of outliers (standardised residual of greater than ±3 standard deviations) for all regression models.

3.4.4.4 Homoscedasticity

Homoscedasticity indicates that the variance of the errors/residuals is constant across all the values of the independent variable. A scatterplot of standardised residuals versus standardised predicted values was generated for all regression models. In all cases, homoscedasticity was found, as assessed by visual inspection of the scatterplot. The scatterplots are provided in Appendix G – Appendix Q.

3.4.4.5 Normally Distributed Residuals

An important assumption of linear regression analysis is that the residuals are normally distributed. A histogram and a normal probability plot were generated for all regression models. In all cases, the residuals were normally distributed as assessed by visual inspection of the histogram and normal probability plot. The histograms and normal probability plots are provided in Appendix G – Appendix Q.

3.5 Chapter Summary

This chapter of the thesis described the methodology used for the broader NICHE project and the research conducted in this thesis. The establishment, objectives, and initial stages of the NICHE project were discussed, followed by the design, development and administration of the NICHE PCMS trial. An overview of the pre-PCMS and post-PCMS surveys, and their administration practices, promotional activities, and sample selection was provided. The conceptual model that underpins the research and the post-PCMS survey items that relate to each of the constructs were described. The chapter concluded with an overview of the statistical analysis undertaken on the post-PCMS survey dataset that is reported in Chapter 5. The next chapter details the characteristics and distributions of key demographic, attitudinal and behavioural survey items for the pre-PCMS and post-PCMS surveys.

Chapter 4 - Descriptive Analysis

4.1 Introduction

This chapter compares demographic and attitudinal data from the pre-PCMS and post-PCMS surveys, and the post-PCMS survey for PCMS users and non-PCMS users. The comparison uses scale means and standard deviations to identify any differences, and Mann Whitney U tests to determine if the differences are statistically significant. The chapter contains the following five sections:

- 4.2 Pre-PCMS and Post-PCMS Survey Demographic Comparison;
- 4.3 Pre-PCMS and Post-PCMS Survey Attitudinal Comparison;
- 4.4 PCMS Users and Non-PCMS Users Demographic Comparison;
- 4.5 PCMS Users and Non-PCMS Users Attitudinal Comparison; and
- 4.6 Usage of the NICHE PCMS.

In Section 4.2, a comparison of demographic data from the pre-PCMS and post-PCMS surveys is undertaken that found both datasets were representative of the broader Norfolk Island population as reported in the 2011 and 2016 censuses. The attitudes of the pre-PCMS and post-PCMS survey respondents across a range of areas are compared in Section 4.3 to highlight any differences following the NICHE PCMS trial. While only minimal changes in attitudes towards PCT were found, there were significant increases in the levels of agreement for the survey items measuring attitudes toward the environment, carbon emissions, and climate change in the post-

PCMS survey. The remainder of the chapter focuses on the post-PCMS survey for PCMS users and non-PCMS users. Section 4.4 shows the demographic data from the post-PCMS survey for PCMS users and non-PCMS users was very similar. In Section 4.5, a comparison of the attitudes of PCMS users and non-PCMS users across a range of areas is undertaken. The comparison found that PCMS users were significantly more likely to believe in anthropogenic climate change and register positive attitudes towards PCT than non-PCMS users. The chapter concludes in Section 4.6 with an examination of the responses to the post-PCMS survey items designed to gather data about the usage of the NICHE PCMS for PCMS users. The examination shows that the majority of PCMS users found the system a valuable use of their time, found the system useful, were more aware of their carbon footprint, were encouraged to reduce their carbon footprint, and would continue to use the system if it was still available. In the discussion that follows in this chapter, if a p-value is not provided, the term **significant** refers to a *p*-value that is less than the alpha level of 0.05.

4.2 Pre-PCMS and Post-PCMS Survey Demographic Comparison

To validate and ensure that the pre-PCMS and post-PCMS survey respondents were representative of the Norfolk Island population, and with each other, demographic variables from each dataset are examined in this section. In 2011, a census was conducted by the Norfolk Island government. In March 2015, the self-governance of Norfolk Island was revoked, and the island was included in the 2016 Australian census. Where possible, demographic data from both surveys is examined against comparative data from the 2011 and 2016 censuses. The pre-PCMS survey was administered closer to the 2011 census than the 2016 census, while the post-PCMS survey was administered closer to the 2016 census that the 2011 census. Therefore, for accuracy, in some cases, the pre-PCMS survey is compared to the 2011 census data, while the post-PCMS survey is compared to the 2016 census data. Where census data does not exist, the responses from the pre-PCMS and post-PCMS surveys are compared with each other.

4.2.1 Response Rates

Based on data from the 2011 census, a copy of the pre-PCMS survey was delivered to each of the 805 occupied households in March 2012, which resulted in 423 responses being received (167 men, 248 women, 8 not recorded). When compared to the 2011 census, this represents a response rate of 52.5% of households for the pre-PCMS survey. In October 2014, a copy of the post-PCMS survey was mailed to all households on Norfolk Island. A total of 177 households responded to the post-PCMS survey (52 men, 121 women, 4 not recorded), resulting in a response rate of 23.5% of households when compared to the 2016 Australian census.

It is recognised that participation rates dropped off between the pre-PCMS and post-PCMS surveys. During the NICHE PCMS trial, the Australian Government revoked the self-governance of Norfolk Island, and the island was incorporated into the state of New South Wales on the Australian mainland. There was tension on the island between those who supported the changes, and those who did not, with some resentment towards the Australian government, which was funding the current research. In addition, there were multiple surveys run on the Island at the same time the post-PCMS was administered related to local political issues and the changes in government that may have resulted in survey fatigue amongst the population. This is expanded on in Section 7.4 when the limitations of the research uncovered during the investigation are discussed. However, based on analysis conducted using G*power software (version 3.1.9.2), it was calculated that sample sizes of 176 for the pre-PCMS survey and 88 for the post-PCMS survey were required to measure changes in attitudes across the Norfolk Island population (Webb, 2018, p. 61). The sample sizes of both surveys exceed these figures.

4.2.2 Age Distribution

Figure 4-1 below shows the age distribution of the pre-PCMS and post-PCMS survey respondents and the age distribution of the adult residents of Norfolk Island, as reported in the 2011 and 2016 censuses. It can be seen that:

- The age distribution of the pre-PCMS survey respondents and the adult residents of Norfolk Island in the 2011 census was very similar; and
- The age distribution of the post-PCMS survey respondents and the adult residents of Norfolk Island in the 2016 census was also very similar.

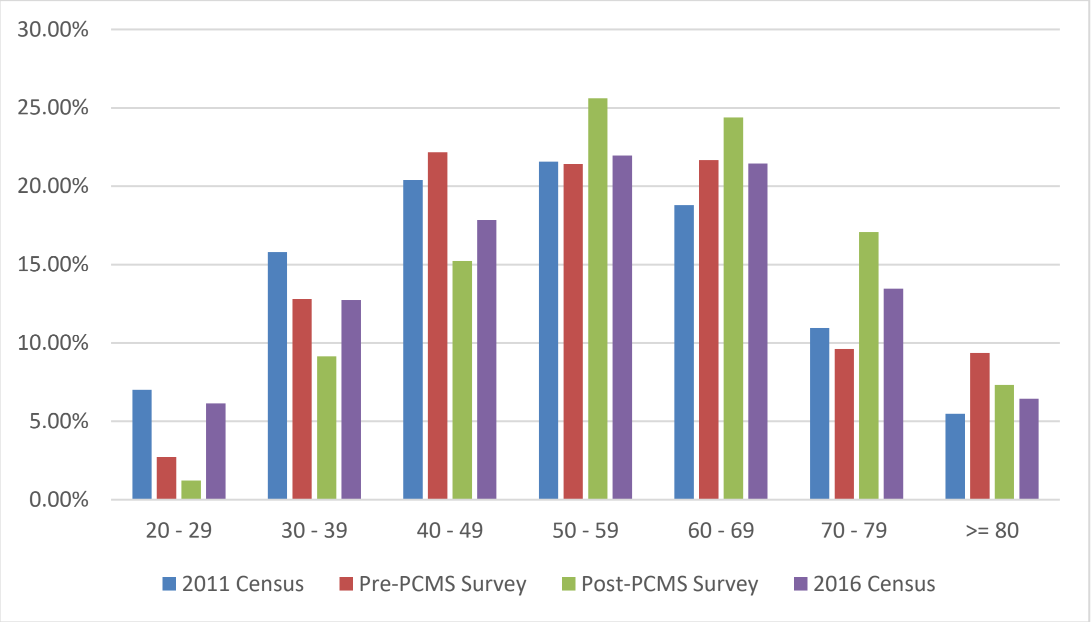

Figure 4-1 Age Distribution of Survey Respondents vs. Census

4.2.3 Household Makeup

Table 4-1 below compares the number of residents and children per household, as reported in the 2011 and 2016 censuses, with corresponding data from the pre-PCMS and post-PCMS surveys. In all cases, an examination of the responses shows that the makeup of the households that responded to the pre-PCMS and post-PCMS surveys was almost identical to the Norfolk Island population.

	2011 Census	Pre-PCMS Survey	2016 Census	Post-PCMS Survey
Residents per household	2.2	2.2	2.2	2.1
Children per household (all Households)	N/A	0.5	0.5	0.4
Children per household (households with children)	N/A	1.8	1.8	1.7

Table 4-1 Household Makeup Pre-PCMS and Post-PCMS Surveys vs. Census

4.2.4 Gender

When compared with the 2011 and 2016 censuses, there were higher participation rates for women in both surveys, as shown in Table 4-2 below. While a little over 50% of the residents of Norfolk Island were women, approximately 60–70% of survey respondents were women. Gender has been shown to influence attitudes towards climate change (see Section 2.3.2.2) and, as a result, the gender difference of the survey respondents are discussed further in Section 7.4 as a limitation of the research.

	2011 Census	Pre-PCMS Survey	2016 Census	Post-PCMS Survey
Men	47.8%	40.2%	46.8%	30.1%
Women	52.2%	59.8%	53.2%	69.9%

Table 4-2 Gender Pre-PCMS and Post-PCMS Surveys vs. Census

4.2.5 Other Demographic Data

Table 4-3 below compares additional demographic data from the pre-PCMS and post-PCMS surveys to establish that the samples were representative of one another. This data was not able to be compared to 2011 or 2016 census data as the survey items measuring the respondent's income and level of education used different values for their scales, and the remaining survey items were not included in either census. The comparison shows that the education, income, health, weight, and self-assessed carbon footprint of the respondents of both surveys were very similar.

What is the highest level of education you have completed?					
	< primary	Primary	Secondary	High school	University
Pre-PCMS	0.24%	0.24%	15.65%	43.52%	40.34%
Post-PCMS	0.00%	0.00%	14.45%	46.24%	39.31%
Roughly, what is your total weekly household income from all sources?					
	<$500	$501–1000	$1001–1500	$1501–2000	>$2000
Pre-PCMS	25.2%	39.9%	23.9%	11.0%	0.0%
Post-PCMS	30.3%	33.3%	22.9%	9.9%	3.7%
Do you generally consider your health to be?					
	Poor	Fair	Good	Very good	Excellent
Pre-PCMS	2.0%	11.0%	44.7%	31.3%	11.0%
Post-PCMS	1.7%	12.0%	36.0%	40.0%	10.3%
How would you best describe yourself?					
	Very underweight	A bit underweight	Healthy weight	A bit overweight	Very overweight
Pre-PCMS	0.2%	6.5%	38.8%	50.7%	3.7%
Post-PCMS	0.6%	5.7%	44.6%	46.3%	2.9%
BMI Band					
	18.5–25	25–30	30–35	> 35	
Pre-PCMS	40.0%	37.8%	16.6%	5.2%	
Post-PCMS	31.9%	41.3%	16.7%	5.1%	
Compared to others on Norfolk Island, do you think your carbon footprint is/would be?					
	Well below average	Below average	About average	Above average	Well above average
Pre-PCMS	6.4%	28.1%	54.4%	8.4%	2.7%
Post-PCMS	6.4%	21.4%	59.7%	10.4%	2.3%

Table 4-3 Demographic Data Pre-PCMS vs. Post-PCMS Survey

4.2.6 Pre-PCMS and Post-PCMS Survey Demographic Summary

It must be noted that:

- The views of non-responding and responding households may differ significantly, and that the views of the individual who completed the survey may not represent the views of the household as a whole;
- Women made up approximately 53% of the population of Norfolk Island, but made up 59.8% of pre-PCMS survey respondents and 69.9% of post-PCMS survey respondents; and
- While the population of Norfolk Island is fairly representative of other developed locations, its small size, geographic isolation, and higher costs for fossil fuels and imported products could reasonably be expected to influence attitudes and behaviours towards the environment and health.

Therefore, while extrapolation of the results to broader populations should be undertaken cautiously, with the exception of the gender difference (discussed further in Section 7.4 as a limitation of the research), the comparisons in this section highlight that the pre-PCMS and post-PCMS survey respondents were representative of the broader Norfolk Island population as reported in the 2011 and 2016 censuses.

4.3 Pre-PCMS and Post-PCMS Survey Attitudinal Comparison

A comparison of the responses to a selection of survey items from the pre-PCMS and post-PCMS surveys that measure attitudes towards PCT, the environment, carbon emissions, climate change, and health is undertaken in this section. These survey items are compared to highlight any differences related to Research Question 1 (*What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?*).

4.3.1 Beliefs about Climate Change

Table 4-4 below shows that there was a small increase in the percentage of respondents who believed humans are largely causing climate change in the post-PCMS survey, although the percentage of respondents who believed that climate change is a natural fluctuation in the earth's temperatures remained constant. A Mann-Whitney U test (N = 571) found that there was no significant difference (U = 36297.0, p = 0.053) in beliefs about the cause of climate change in the pre-PCMS and post-PCMS surveys.

What best describes your thoughts about climate change?				
	Not happening	Not sure	Natural fluctuation in earth's temperatures	Humans are largely causing it
Pre-PCMS	1.7%	5.2%	31.9%	61.2%
Post-PCMS	1.2%	0.0%	31.4%	67.5%

Table 4-4 Climate Change Beliefs Pre-PCMS vs. Post-PCMS Survey

4.3.2 PCTS Attitudes

The pre-PCMS survey had ten survey items (E1–E10) that were designed to measure the survey respondents' attitudes towards PCTS. The pre-PCMS analysis identified these survey items as loading on the *Usage Intentions towards a PCTS* factor (see Section 2.4). In the post-PCMS survey, five of these survey items were answered by all survey respondents, while the other five were only answered by PCMS users. Due to the anonymous nature of both surveys, it was not possible to compare the pre and post attitudes towards PCTS for PCMS users and non-PCMS users (see Section 3.3.1). Therefore, the comparison of the pre and post attitudes towards PCTS in this section is based on the survey items that were answered by *all* post-PCMS survey respondents. These survey items are listed below in Table 4-5 with their pre-PCMS and post-PCMS survey identifiers as these changed between surveys. The post-PCMS Survey Item F5 was re-phrased to gather data about the NICHE PCMS as opposed to a generic PCTS. The survey item *there is a strong link between a person's carbon footprint and their health* does not appear to be directly asking the respondent about their attitudes towards PCT. However, it is discussed in this section as it loaded on the *Usage Intentions towards a PCTS* factor in the pre-PCMS analysis, thereby indicating that the pre-PCMS survey respondents saw it as being related to PCT.

Pre-PCMS Survey	Post-PCMS Survey
E1. Being able to measure my carbon footprint is important to me.	F1. Being able to measure my carbon footprint is important to me.
E2. Most people would accept a PCT system as a tool for improving the environment.	F5. Most people would accept the NICHE carbon card system as a tool for improving the environment.
E5. People who reduce their carbon footprint should be rewarded in some way.	F7. People who reduce their carbon footprint should be rewarded in some way.
E6. People with a greater carbon footprint should have to pay for it in some way.	F8. People with a greater carbon footprint should have to pay for it in some way.
E10. There is a strong link between a person's carbon footprint and their health.	D22. There is a strong link between a person's carbon footprint and their health.

Table 4-5 PCTS Attitudes Survey Item Identifiers

The responses, means, and standard deviations for these survey items are compared in Table 4-6 below to examine whether attitudes towards PCTS changed following the NICHE PCMS trial. The results of the Mann-Whitney U tests that were run on these survey items to determine if there were significant differences between the pre-PCMS and post-PCMS surveys can be seen at the bottom of Table 4-6. The survey items in this section had scale descriptors ranging from *1 – "strongly agree"* to *7 – "strongly disagree"* with a midpoint of *4 – "neutral"*. For simplicity of reading, the table below (and in the following sections of this chapter) is presented as follows. The percentage of respondents who chose 1, 2, or 3, thus indicating that they agreed with the survey items, have been combined into one row (Agree (1–3)), and those who chose 5, 6, or 7 have been combined into another row (Disagree (5–7)). The mean and standard deviation for each survey item was calculated on the full set of data, not the abbreviated data.

Pre-PCMS Survey	E1	E2	E5	E6	E10
Agree (1–3)	56.4%	51.2%	56.1%	50.0%	56.4%
Neutral (4)	38.3%	33.7%	33.5%	31.7%	36.5%
Disagree (5–7)	5.3%	15.1%	10.4%	18.3%	7.1%
Mean	3.13	3.44	3.16	3.39	3.13
Std. Deviation	1.277	1.328	1.362	1.511	1.287
Post-PCMS Survey	F1	F5	F7	F8	D22
Agree (1–3)	60.4%	55.5%	52.4%	40.7%	70.9%
Neutral (4)	30.8%	29.9%	30.4%	29.3%	20.9%
Disagree (5–7)	8.9%	14.6%	17.3%	29.9%	8.2%
Mean	3.01	3.06	3.35	3.75	2.49
Std. Deviation	1.320	1.485	1.597	1.741	1.521
Mann-Whitney U Tests					
Mann-Whitney U	32119.5	27764.0	32035.5	29359.5	18603.0
Significance	0.314	0.005	0.376	0.027	< 0.001

Table 4-6 PCTS Attitudes Pre-PCMS vs. Post-PCMS Survey

Table 4-6 above shows that, in the post-PCMS survey, there was a significant decrease in agreement for *people with a greater carbon footprint should have to pay for it in some way* (Survey Item E6 pre-PCMS, F8 post-PCMS). For the survey items listed below, there was a significant increase in agreement in the post-PCMS survey, and the means for these survey items have decreased, thereby indicating stronger levels of agreement.

- Most people would accept a PCTS (pre-PCMS wording) / the NICHE carbon card system (post-PCMS wording) as a tool for improving the environment (Survey Item E2 pre-PCMS analysis, F5 post-PCMS, $p = 0.005$); and

- There is a strong link between a person's carbon footprint and their health (Survey Item E10 pre-PCMS, D22 post-PCMS, $p < 0.001$).

The results in this section show that, while support for pricing for increased carbon emissions has fallen following the NICHE PCMS trial, it appears that the NICHE PCMS trial has changed the post-PCMS survey respondents' belief in the likely acceptance of a PCMS as a tool to bring about environmental change.

4.3.3 Attitudes towards the Environment, Carbon Emissions and Climate Change

The pre-PCMS and post-PCMS surveys contained the following survey items designed to gather data related to the respondent's attitudes towards the environment, carbon emissions, and climate change:

- B1. I buy environmentally friendly products as much as I can;
- B5. It is important for me to have a low carbon footprint;
- B6. A financial incentive would encourage me to reduce my environmental impact;
- B7. Collectively, households can reduce the impacts of greenhouse gas emissions; and
- B13. I am worried about climate change.

The responses, means, and standard deviations for these survey items are shown in Table 4-7 below, together with the results of the Mann-Whitney U tests that were run to determine if there were significant differences in the pre-PCMS and post-PCMS surveys for these survey items.

Pre-PCMS Survey	B1	B5	B6	B7	B13
Agree (1–3)	68.4%	80.5%	55.3%	86.1%	72.2%
Neutral (4)	25.4%	16.8%	29.8%	8.9%	18.4%
Disagree (5–7)	6.2%	2.7%	14.9%	5.0%	9.3%
Mean	2.80	2.45	3.27	2.25	2.69
Std. Deviation	1.298	1.213	1.555	1.279	1.515
Post-PCMS Survey	B1	B5	B6	B7	B13
Agree (1–3)	75.0%	83.8%	55.3%	93.0%	76.2%
Neutral (4)	20.9%	12.7%	22.9%	4.1%	15.7%
Disagree (5–7)	4.1%	3.5%	21.8%	2.9%	8.1%
Mean	2.37	2.15	3.30	1.81	2.37
Std. Deviation	1.324	1.168	1.786	1.059	1.403
Mann-Whitney U Tests					
Mann-Whitney U	27401.0	29287.0	33048.5	26517.5	29787.0
Significance	< 0.001	0.007	0.909	< 0.001	0.017

Table 4-7 Attitudes towards Carbon Emissions and Climate Change Pre-PCMS vs. Post-PCMS Survey

Table 4-7 above shows that there was no significant (p = 0.909) difference in agreement for Survey Item B6 (*A financial incentive would encourage me to reduce my environmental impact*) in the pre-PMS and post-PCMS surveys. For all other survey items, there was a significant increase in agreement in the post-PCMS survey and a decrease in the mean, thus indicating stronger levels of agreement. The results of the analysis in this section show that survey respondents were more likely to register concern about climate change and positive attitudes towards the environment and emissions reductions in the post-PCMS survey following the NICHE PCMS trial.

4.3.4 Attitudes towards Health

The pre-PCMS and post-PCMS surveys contained the following survey items designed to gather data related to the respondent's attitudes toward health:

- B3. Being overweight can have serious health effects;
- B8. I always try to eat healthy food;
- B9. I am confident I could maintain a healthy body weight if I wanted to;
- B11. Walking or cycling instead of using the car can help reduce a person's weight; and
- B12. I am unlikely to ever be obese.

Table 4-8 below shows the responses, means, standard deviations, and the results of the Mann-Whitney U tests for these survey items.

Pre-PCMS Survey	B3	B8	B9	B11	B12
Agree (1–3)	93.64%	83.09%	85.15%	95.37%	63.86%
Neutral (4)	1.47%	12.50%	10.40%	2.44%	18.81%
Disagree (5–7)	4.89%	4.41%	4.46%	2.20%	17.33%
Mean	1.82	2.48	2.36	1.82	2.87
Std. Deviation	1.274	1.173	1.204	1.053	1.753
Post-PCMS Survey	B3	B8	B9	B11	B12
Agree (1–3)	91.33%	90.70%	84.30%	94.80%	70.93%
Neutral (4)	2.31%	5.81%	12.21%	2.31%	12.79%
Disagree (5–7)	6.36%	3.49%	3.49%	2.89%	16.28%
Mean	1.67	1.99	2.20	1.57	2.64
Std. Deviation	1.391	1.111	1.300	1.047	1.804
Mann-Whitney U Tests					
Mann-Whitney U	29696.5	25379.0	30313.0	28549.5	30804.5
Significance	0.004	< 0.001	0.048	< 0.001	0.094

Table 4-8 Attitudes towards Health Pre-PCMS vs. Post-PCMS Survey

Table 4-8 above shows that the percentage of respondents who agreed with Survey Item B12 (*I am unlikely to ever be obese*) increased in the post-PCMS survey although the difference was not significant ($p = 0.094$). For Survey Item B8 (*I always try to eat healthy food*), there was an increase in agreement in the post-PCMS survey, and the difference was significant. For all other survey items, the percentage of respondents who agreed was similar in the pre-PCMS survey and post-PCMS surveys. Nevertheless, in all cases, the mean has fallen in the post-PCMS survey, thus indicating stronger levels of agreement, and the Mann-Whitney U tests show the differences were significant. These results indicate that while the changes were not substantial, post-PCMS survey respondents were more likely to register positive attitudes towards health than pre-PCMS survey respondents.

4.3.5 Pre-PCMS and Post-PCMS Attitudinal Summary

No significant difference was found in anthropogenic climate change beliefs following the NICHE PCMS trial. When attitudes towards PCT were compared, a significant increase in agreement towards Survey Item F5 (*Most people would accept the NICHE carbon card system as a tool for improving the environment*) and a significant decrease in agreement towards Survey Item F8 (*People with a greater carbon footprint should have to pay for it in some way*) was found in the post-PCMS survey. It appears that, following the NICHE PCMS trial, the most substantial changes were the significant increases in agreement to the survey items that measured attitudes towards the environment, carbon emissions, and climate change, and to a lesser degree, attitudes towards health. These results will be investigated further in the next chapter when regression models run on the post-PCMS survey dataset are compared with the pre-PCMS analysis, and the significant predictors of attitudes towards PCTS are examined.

4.4 PCMS Users and Non-PCMS Users Demographic Comparison

Section 4.2 highlighted that the respondents of the post-PCMS survey were representative of the broader Norfolk Island population as reported in the 2016 census. A comparison of demographic data from the post-PCMS survey for PCMS users and non-PCMS users is undertaken in this section to highlight any differences between the groups.

4.4.1 Response Rates

While multiple individuals from each household could register for the NICHE PCMS trial, carbon emissions were monitored at a household level, for the whole household. Therefore, if more than one person from a household registered, their accounts were combined. In total, there were 298 (130 men, 168 women) registered PCMS users from 218 households. As stated in Chapter 3, only one person per household could complete the post-PCMS survey. The post-PCMS survey contained Survey Item F10 (*Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?*) which had the following three options:

1. Yes, I had a NICHE carbon card and was entitled to the fuel discount;
2. I didn't have a NICHE carbon card, but somebody else in this household did; and
3. No one in this household registered for the NICHE carbon card.

The definitions of PCMS users and non-PCMS users were provided in Chapter 1. Post-PCMS survey respondents were categorised as **PCMS users** if they selected Option 1, and personally registered for the NICHE PCMS trial. Post-PCMS survey respondents were categorised as **non-PCMS users** if they selected Option 3 and no one in the household registered for the NICHE PCMS trial. The additional survey items in the post-PCMS survey for participants of the NICHE PCMS trial were designed to be answered by the individual who had personally registered and, as such, were only answered by PCMS users. Therefore, these survey items were not applicable for post-PCMS survey respondents who selected Option 2, indicating that they came from household that participated in the NICHE PCMS trial, but they were not personally responsible for registering their household. In the analysis in this chapter and later chapters, the responses from these individuals were included when the full post-PCMS dataset was used. However, they were removed from the analysis when comparing PCMS users and non-PCMS users as they did not fall into either of these categories.

Of the 170 valid responses to this survey item, there were 76 non-PCMS users (29 men, 45 women), and 88 PCMS users (19 men, 69 women), which resulted in a response rate of 40.4% of all households that participated in the NICHE PCMS trial.

4.4.2 Age Distribution

Figure 4-2 below compares:

- The age distribution of PCMS users who responded to the post-PCMS survey (Blue ‘Survey PCMS users’ in the chart legend);
- The age distribution of non-PCMS users who responded to the post-PCMS survey (Red ‘Survey non-PCMS users’ in the chart legend);
- The age distribution of ALL PCMS users who registered for the trial. This includes those who responded to the post-PCMS survey, and those who did not (Green ‘All PCMS users’ in the chart legend); and

- The age distribution of Norfolk Islanders as reported in the 2016 census (Purple ‘2016 census’ in the chart legend).

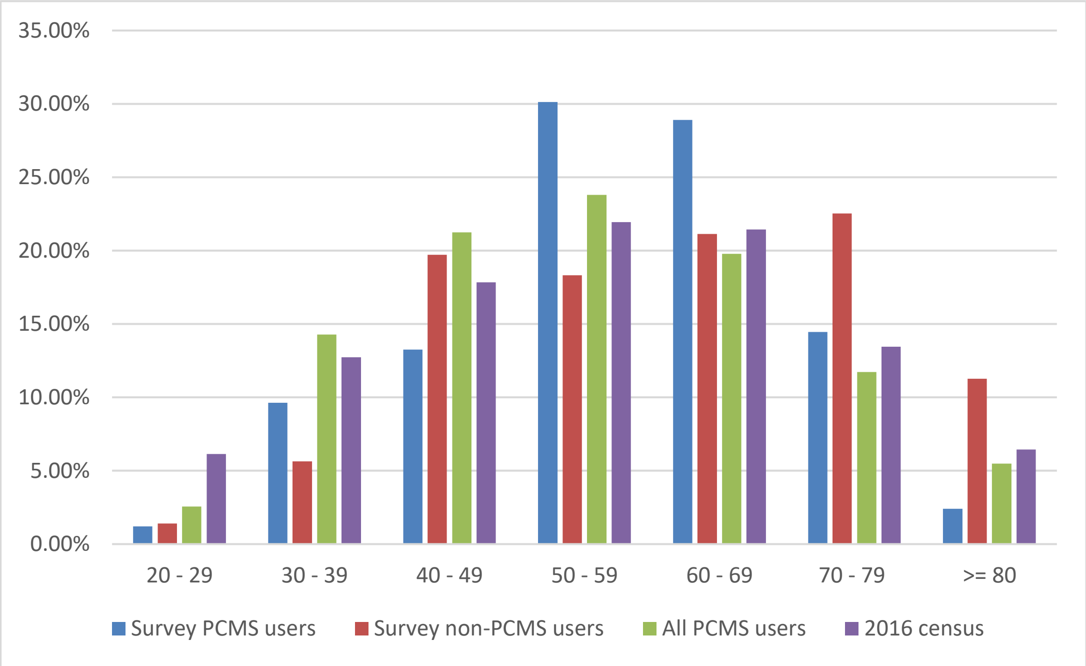

Figure 4-2 Age Distribution of PCMS Users and Non-PCMS Users vs. Census

Figure 4-2 above shows that the age distribution of ‘All PCMS users’ (those who responded to the post-PCMS survey, and those who did not) was representative of the adult population of Norfolk Island as reported in the 2016 census. The age distribution of ‘Survey PCMS users’ (PCMS users who responded to the post-PCMS survey) was higher in the 50–59 and 60–69 age bands when compared to the 2016 census. Whereas the age distribution of ‘Survey non-PCMS users’ (non-PCMS users who responded to the post-PCMS survey) was higher in the 70–79 and 80+ age band when compared to the 2016 census. These differences are discussed further in Section 4.4.5 of this chapter.

4.4.3 Gender

When compared with the 2016 censuses, women were slightly more likely than men to register their household for the NICHE PCMS trial, as shown in the 'All PCMS users' column in Table 4-9 below. However, of the PCMS users who responded to the post-PCMS survey, 78.4% were women. The difference in gender participation in the post-PCMS survey for PCMS users is discussed further in Section 4.4.5 of this chapter.

	2016 Census	All PCMS Users	Survey PCMS Users	Survey non-PCMS Users
Men	46.8%	43.6%	21.6%	39.2%
Women	53.2%	56.4%	78.4%	60.8%

Table 4-9 Gender PCMS Users and Non-PCMS Users vs. Census

4.4.4 Other Demographic Data

Table 4-10 below compares other demographic post-PCMS survey data for PCMS users and non-PCMS users. The comparison shows that the education, income, health, weight, and self-assessed carbon footprint of PCMS users and non-PCMS users were very similar.

What is the highest level of education you have completed?					
	< primary	Primary	Secondary	High school	University
PCMS Users	0.0%	0.0%	14.9%	47.1%	37.9%
Non-PCMS Users	0.00%	0.00%	14.7%	42.7%	42.7%
Roughly, what is your total weekly household income from all sources?					
	<$500	$501–1000	$1001–1500	$1501–2000	>$2000
PCMS users	26.5%	36.1%	27.7%	7.2%	2.4%
Non-PCMS Users	33.8%	26.5%	19.1%	14.7%	5.9%
Do you generally consider your health to be?					
	Poor	Fair	Good	Very good	Excellent
PCMS Users	1.1%	9.1%	36.4%	39.8%	13.6%
Non-PCMS Users	2.7%	16.0%	32.0%	44.0%	5.3%
How would you best describe yourself?					
	Very underweight	A bit underweight	Healthy weight	A bit overweight	Very overweight
PCMS Users	0.0%	1.1%	44.3%	53.4%	1.1%
Non-PCMS Users	1.3%	12.0%	38.7%	42.7%	5.3%
BMI Band					
	18.5–25	25–30	30–35	> 35	
PCMS Users	31.9%	34.7%	20.8%	6.9%	
Non-PCMS Users	28.8%	49.2%	13.6%	3.4%	
Compared to others on Norfolk Island, do you think your carbon footprint is/would be?					
	Well below average	Below average	About average	Above average	Well above average
PCMS Users	5.7%	24.1%	56.3%	11.5%	2.3%
Non-PCMS Users	6.7%	17.3%	65.3%	8.0%	2.7%

Table 4-10 Demographic Data PCMS Users vs. Non-PCMS Users

4.4.5 PCMS Users and Non-PCMS Users Demographic Summary

While the results in this section show that the age distribution of *all* PCMS users (those who responded to the survey and those who did not) was representative of the adult population of Norfolk Island as reported in the 2016 census, it must be noted that:

- The age distribution of PCMS users who responded to the post-PCMS survey was higher in the 50–59 and 60–69 age bands;
- The age distribution of non-PCMS users who responded to the post-PCMS survey was higher in the 70–79 and 80+ age bands; and
- Women made up a higher proportion of post-PCMS survey respondents in both the PCMS user and non-PCMS user categories.

The review of the literature (see Section 2.3.2.2) shows that age and gender can influence concern about, and willingness to take action on climate change. It is noted that this may have an impact on the results of the research and should be considered a limitation of the study, as outlined in Section 7.4. Nevertheless, this section has highlighted that demographic data such as education, income, self-assessed body weight and health, and self-assessed carbon footprint of PCMS users and non-PCMS users were similar.

4.5 PCMS Users and Non-PCMS Users Attitudinal Comparison

A comparison of attitudinal data from the post-PCMS survey for PCMS users and non-PCMS users is undertaken in this section to highlight any differences between the groups pertaining to Research Question 2 (*What differences in attitudes towards PCTS will be evident between those who volunteered for the NICHE PCMS trial and those who did not?*). The characteristics of PCMS users identified in this section are also used to examine Research Question 3 (*What factors influenced the usage behaviour of the NICHE PCMS?*).

4.5.1 Beliefs about Climate Change

Table 4-11 below shows that 75.3% of PCMS users believed that humans are causing climate change, compared with 57.5% of non-PCMS users, and the results of the Mann-Whitney U test (N = 153) showed that the difference was significant (U = 2450.0, $p = 0.043$). It is interesting to note that only 1.2% of PCMS users and 1.4% of non-PCMS users believed that climate change was not happening. The differences between PCMS users and non-PCMS users were about the cause of climate change, not its existence.

What best describes your thoughts about climate change?				
	Not happening	Not Sure	Natural fluctuation in the earths temperatures	Humans are largely causing it
PCMS Users	1.2%	0.0%	23.5%	75.3%
Non-PCMS Users	1.4%	0.0%	41.1%	57.5%

Table 4-11 Climate Change Beliefs PCMS Users vs. Non-PCMS Users

4.5.2 PCTS Attitudes

The following five survey items were included in the post-PCMS survey as measures of PCTS attitudes and were answered by all survey respondents:

- F1. Being able to measure my carbon footprint is important to me;
- F5. Most people would accept the NICHE carbon card system as a tool for improving the environment;
- F7. People who reduce their carbon footprint should be rewarded in some way;
- F8. People with a greater carbon footprint should have to pay for it in some way; and
- D22. There is a strong link between a person's carbon footprint and their health.

An additional two survey items were included in the post-PCMS survey as measures of the *Voluntariness* construct in the proposed conceptual model that were also answered by all survey respondents:

- F6. It should be compulsory for people to monitor the size of their carbon footprint; and
- F9. I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island.

The responses for PCMS users and non-PCMS users, along with the mean and standard deviation for these survey items can be seen below in Table 4-12. The outputs of the Mann-Whitney U tests that were run to determine if there were significant differences in PCTS Attitudes for PCMS users and non-PCMS users are located at the bottom of Table 4-12. As was the case in the previous section, the percentage of respondents who chose 1, 2, or 3, indicating that they agreed with the survey item, have been combined into one row (Agree (1–3)), and those who chose 5, 6, or 7 have been combined into another row (Disagree (5–7)). The mean and standard deviation for the survey items were calculated on the full set of data, not the abbreviated data.

	D22	F1	F5	F6	F7	F8	F9
PCMS Users							
Agree (1–3)	77.9%	76.1%	65.9%	47.7%	51.1%	46.0%	60.5%
Neutral (4)	19.5%	21.6%	23.9%	34.1%	38.6%	32.2%	26.7%
Disagree (5–7)	2.6%	2.3%	10.2%	18.2%	10.2%	21.8%	12.8%
Mean	2.38	2.68	2.80	3.52	3.37	3.49	3.14
Std. Deviation	1.376	1.136	1.371	1.606	1.365	1.547	1.505
Non-PCMS Users							
Agree (1–3)	63.3%	38.9%	42.6%	22.2%	56.3%	32.4%	26.8%
Neutral (4)	22.4%	44.4%	38.2%	34.7%	22.5%	29.6%	38.0%
Disagree (5–7)	14.3%	16.7%	19.1%	43.1%	21.1%	38.0%	35.2%
Mean	2.53	3.50	3.36	4.46	3.22	4.12	4.09
Std. Deviation	1.687	1.398	1.516	1.799	1.824	1.838	1.703
Mann-Whitney U Tests							
Mann-Whitney U	1738.5	4042.0	3372.5	3890.5	2602.0	3429.5	3820.5
Significance	0.874	< 0.001	0.023	0.001	0.242	0.039	< 0.001

Table 4-12 PCTS Attitudes PCMS Users vs. Non-PCMS Users

The results of the Mann-Whitney U tests for the following survey items show that the differences in responses for PCMS users and non-PCMS users were not significant:

- F7. People who reduce their carbon footprint should be rewarded in some way ($p = 0.242$); and
- D22. There is a strong link between a person's carbon footprint and their health ($p = 0.874$).

For all other measures of PCTS attitudes in this section, PCMS users were considerably more likely to agree with the survey items, and the means for the survey items were lower, indicating stronger levels of agreement. In all cases, the Mann-

Whitney U tests showed that the differences between PCMS users and non-PCMS users for these survey items were significant. The results in this section highlight that PCMS users were more likely to register positive attitudes towards PCTS than non-PCMS users.

4.5.3 Attitudes towards the Environment, Carbon Emissions and Climate Change

The following five survey items were included in the post-PCMS survey to gather data related to attitudes toward the environment, carbon emissions, and climate change and were answered by all survey respondents:

- B1. I buy environmentally friendly products as much as I can;
- B5. It is important for me to have a low carbon footprint;
- B6. A financial incentive would encourage me to reduce my environmental impact;
- B7. Collectively, households can reduce the impacts of greenhouse gas emissions; and
- B13. I am worried about climate change.

The responses, means, standard deviations, and the results of the Mann-Whitney U tests for these survey items for PCMS users and non-PCMS users can be seen below in Table 4-13.

	B1	B5	B6	B7	B13
PCMS Users					
Agree (1–3)	77.0%	89.8%	55.2%	97.7%	81.6%
Neutral (4)	18.4%	9.1%	25.3%	1.1%	13.8%
Disagree (5–7)	4.6%	1.1%	19.5%	1.1%	4.6%
Mean	2.36	2.06	3.33	1.78	2.26
Std. Deviation	1.319	1.038	1.697	.900	1.321
Non-PCMS Users					
Agree (1–3)	71.6%	78.4%	58.9%	89.0%	70.3%
Neutral (4)	24.3%	16.2%	17.8%	8.2%	18.9%
Disagree (5–7)	4.1%	5.4%	23.3%	2.7%	10.8%
Mean	2.46	2.26	3.22	1.84	2.46
Std. Deviation	1.337	1.224	1.924	1.158	1.491
Mann-Whitney U Tests					
Mann-Whitney U	3144.0	3274.0	2801.0	2897.5	3200.0
Significance	0.620	0.398	0.542	0.786	0.481

Table 4-13 Attitudes towards Carbon Emissions and Climate Change PCMS Users vs. Non-PCMS users

The results in Table 4-13 above show that non-PCMS users were more likely to agree with Survey Item B6 (*A financial incentive would encourage me to reduce my environmental impact*) than PCMS users. In all other cases, PCMS users were more likely to agree with the survey items, and the mean was lower. It must be noted, though, that the differences in the mean and standard deviation for all of the survey items were only slight, and the results of the Mann-Whitney tests show that there was no significant difference between PCMS users and non-PCMS users for any of the survey items in this section. Therefore, it appears that, while PCMS users were slightly more likely to agree with most of the survey items, there does not appear to be a significant difference between PCMS users and non-PCMS users in their attitudes towards the environment, carbon emissions, and climate change. These results are discussed further in Section 4.5.5 of this chapter, where the attitudinal differences between PCMS users and non-PCMS users are summarised.

4.5.4 Attitudes towards Health

The post-PCMS survey contained the following survey items designed to gather data related to attitudes toward health that were answered by all survey respondents:

- B3. Being overweight can have serious health effects;
- B8. I always try to eat healthy food;
- B9. I am confident I could maintain a healthy body weight if I wanted to;
- B11. Walking or cycling instead of using the car can help reduce a person's weight; and
- B12. I am unlikely to ever be obese.

The responses, means, and standard deviations to the above survey items are shown in Table 4-14 below, together with the results of the Mann-Whitney U tests that were run to determine if there were significant differences in attitudes towards health for PCMS users and non-PCMS users.

	B3	B8	B9	B11	B12
PCMS Users					
Agree (1–3)	96.6%	89.8%	88.6%	97.7%	71.3%
Neutral (4)	1.1%	6.8%	10.2%	2.3%	16.1%
Disagree (5–7)	2.3%	3.4%	1.1%	0.0%	12.6%
Mean	1.48	2.09	2.08	1.47	2.51
Std. Deviation	.891	1.074	1.102	.729	1.614
Non-PCMS Users					
Agree (1–3)	87.8%	94.5%	82.2%	94.6%	68.9%
Neutral (4)	4.1%	4.1%	12.3%	1.4%	10.8%
Disagree (5–7)	8.1%	1.4%	5.5%	4.1%	20.3%
Mean	1.77	1.84	2.32	1.60	2.83
Std. Deviation	1.626	.994	1.470	1.134	2.036
Mann-Whitney U Tests					
Mann-Whitney U	2990.5	2592.5	3153.5	3078.5	3145.0
Significance	0.932	0.122	0.570	0.889	0.619

Table 4-14 Attitudes towards Health PCMS Users vs. Non-PCMS users

Table 4-14 above shows that a higher percentage of non-PCMS users agreed with Survey Item B8 (*I always try to eat healthy food*) than PCMS users. For all other survey items, PCMS users were more likely to register agreement; however, for all survey items in this section, the Mann-Whitney U tests show that there were no significant differences between PCMS users and non-PCMS users in their attitudes towards health.

4.5.5 PCMS Users and Non-PCMS Users Attitudinal Summary

There was no significant difference found for the survey items that measured attitudes towards the environment, carbon emissions, and climate change. These results were a surprise as it was expected that PCMS users would register significantly higher levels of agreement to these survey items, given they voluntarily participated in the NICHE PCMS trial. The main differences found between PCMS users and non-PCMS users were their beliefs about the cause of climate change, and their attitudes towards PCT. PCMS users were significantly more likely to believe that humans are causing climate change than non-PCMS users, and were significantly more likely to register positive attitudes towards PCT. This could be expected as it is reasonable to assume that these attitudes would have played a role in their voluntary usage of the NICHE PCMS. These differences will be investigated further in the next chapter, where the significant predictors of attitudes towards PCT are compared for PCMS users and for non-PCMS users.

4.6 Usage of the NICHE PCMS

The survey items listed below were only included in the post-PCMS survey and were only answered by PCMS users. The responses to these survey items are highlighted in this section of the thesis as these survey items were designed to gather data about the usage of the NICHE PCMS, and are used as measures for some of the constructs in the proposed conceptual model that was developed to examine Research Question 3 (*What factors influenced the usage behaviour of the NICHE PCMS?*).

- F13. It was easy to use the NICHE carbon card at the petrol station;
- F14. It has been a valuable use of my time to review the size of my household's carbon footprint;
- F15. Being able to review information about the size of my carbon footprint has saved me money;
- F16. The information about my household's carbon footprint provided by the NICHE carbon card system was very useful;
- F17. Using the NICHE carbon card system has made me more aware of my carbon footprint;
- F18. The NICHE carbon card system has encouraged me to reduce my carbon footprint;
- F19. The NICHE carbon card system has encouraged me to walk or cycle more and drive less;
- F20. The NICHE carbon card system has helped me to monitor my environmental impact;
- F21. Comparing my household's carbon usage to the NICHE household average influenced my consumption habits;
- F22. Comparing my household's carbon usage to the NICHE Target influenced my consumption habits; and

- F23. If it was still available, I would continue to use the NICHE carbon card system to monitor my personal carbon footprint (when answering this question assume that there are no fuel discounts).

The responses to these survey items are shown in Table 4-15 below. For ease of reading, the percentage of respondents who chose 1, 2, or 3, indicating they agreed with the survey item, are combined into one row (Agree (1–3)), and those who chose 5, 6, or 7 are combined into another row (Disagree (5–7)).

	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23
Agree (1–3)	85.2%	67.1%	34.2%	60.7%	76.2%	67.1%	32.1%	58.3%	47.0%	43.9%	61.9%
Neutral (4)	8.0%	27.1%	52.4%	33.3%	19.0%	26.8%	39.3%	31.0%	36.1%	36.6%	27.4%
Disagree (5–7)	6.8%	5.9%	13.4%	6.0%	4.8%	6.1%	28.6%	10.7%	16.9%	19.5%	10.7%

Table 4-15 Usage of the NICHE PCMS Post-PCMS Survey

A higher percentage of PCMS users were neutral, as opposed to agreeing with Survey Item F19 (*The NICHE carbon card system has encouraged me to walk or cycle more and drive less*) and Survey Item F15 (*Being able to review information about the size of my carbon footprint has saved me money*). PCMS users overwhelmingly agreed with all other survey items in this section that were included in the post-PCMS survey to gather data about the usage of the NICHE PCMS. These results highlight the role that a PCMS can play in educating users about their carbon footprint and the potential benefits of a PCMS in emission reduction efforts and are discussed further in the following chapters.

4.7 Chapter Summary

This chapter began with a comparison of demographic data from the pre-PCMS and post-PCMS surveys and the 2011 and 2016 censuses. A comparison of attitudinal data from the pre-PCMS and post-PCMS surveys followed to highlight any differences following the NICHE PCMS trial. Demographic and attitudinal data from the post-PCMS survey for PCMS users and non-PCMS users was then examined to identify any differences between the groups. The chapter concluded with an examination of the responses to the survey items designed to gather data about the usage of the NICHE PCMS. The next chapter discusses the statistical analysis that was undertaken on the post-PCMS survey dataset to examine the three research questions and the proposed conceptual model.

Chapter 5 - Data Analysis

5.1 Introduction

This chapter describes the statistical analysis undertaken on the post-PCMS survey dataset. The chapter commences with an overview of the post-PCMS dataset preparation. The correlation analysis and EFA conducted on the post-PCMS dataset are described, followed by an in-depth discussion of the post-PCMS regression analysis used to examine the three research questions. In the discussion that follows in this chapter, if a p-value is not provided, the term **significant** refers to a *p*-value that is less than the alpha level of 0.05.

In the first stage of the post-PCMS regression analysis, regression models run on the post-PCMS dataset measuring *PCTS Attitudes* were compared with a similar regression model from the pre-PCMS analysis to examine Research Question 1 (*What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?*). The comparison shows that there was a shift in attitudes following the NICHE PCMS trial, represented by the increased variance across the significant blocks of variables with an 'environmental' focus that measured attitudes and behaviours towards the environment, carbon emissions and climate change.

In the second stage of the regression analysis, the post-PCMS regression models measuring *PCTS Attitudes* were further moderated for PCMS users and non-PCMS users to examine Research Question 2 (*What differences in attitudes towards PCTS* *will be evident between those who volunteered for the NICHE PCMS trial and those who did not?*). The results show that, in the models for PCMS users, much greater levels of variance in *PCTS Attitudes* were predicted by the blocks of variables with an 'environmental' focus. In contrast, in the models for non-PCMS users, much greater levels of variance in *PCTS Attitudes* were predicted by the 'health' related blocks of variables, and in particular, the significant individual variables that measured attitudes towards body weight.

In the final stage of the regression analysis, post-PCMS regression models measuring the *Usage Behaviour of the NICHE PCMS* were examined for Research Question 3 (*What factors influenced the usage behaviour of the NICHE PCMS?*). The results show that the *Usage Behaviour of the NICHE PCMS* was predicted by *Consumer Consciousness*, *Carbon Consciousness*, *Voluntariness*, *Intention to Use*, *Perceived Ease of Use*, and *Perceived Usefulness*.

5.2 Post-PCMS Survey Data Preparation

Outliers, disengaged responses and missing values are frequently encountered when collecting data and need to be addressed before commencing any statistical analysis. In addition, normality tests should be undertaken (Hair et al., 2010, p. 47; Lund, 2018). This section discusses the methods that were used to prepare the post-PCMS dataset for statistical analysis.

5.2.1 Missing Values

Missing values in a dataset reduce the amount of data that is available to be analysed and can compromise the reliability of the results. Hair et al. (2010, p. 47) suggest that, if the missing data is under 10% for an individual variable, it can generally be ignored. The post-PCMS survey dataset was tested for missing values. The highest level of missing data for any of the variables used in the statistical analysis was 6.8% and, in all but three cases, the level of missing data was under 5%. As a result, the missing values were ignored. To deal with the missing values in the EFA and regression analysis that is discussed later in this section, list-wise deletion was used where a case is dropped from the analysis if one or more of the specified variables is missing a value.

5.2.2 Outliers

An inspection of the post-PCMS survey dataset was undertaken to check for outliers. With the exception of some demographic data, all survey items used in the analysis were closed-ended and used Likert-type scales to measure user responses. Checks were performed to confirm that all responses were within the valid ranges represented by the Likert-type scales. The demographic data was checked against valid ranges for its type. No outliers were found in the post-PCMS survey dataset. When running the regression analysis reported later in this chapter, a case-wise diagnostics table was generated to confirm the absence of outliers (standardised residual of greater than ±3 standard deviations). Based on the case-wise diagnostics, the responses of four post-PCMS survey respondents were removed from the analysis.

5.2.3 Disengaged Responses

The final data preparation test was for disengaged responses. Disengaged responses are identified by examining the standard deviation of the responses for each survey respondent. If the standard deviation is less than 0.5, this indicates that the respondent has answered similarly for all items in the survey, and the survey responses for that respondent should be removed from the dataset (Tabachnick & Fidell, 2013). The post-PCMS survey dataset was tested for disengaged responses, and no problems were found.

5.2.4 Normality Tests

A graphical analysis of normality was undertaken on each variable in the post-PCMS dataset using a frequency distribution (histogram) and a Q-Q plot (quantile-quantile plot). Statistical tests were also used to calculate values for the skewness and kurtosis. There were some cases where the critical values for skewness and kurtosis for the attitudinal and behavioural survey items were higher than ±2.58 (0.01 significance level). These variables were not discarded or transformed for the following reasons:

- Similar results were found for these survey items in the pre-PCMS analysis. Over half of the households on Norfolk Island responded to the pre-PCMS survey (see Section 4.2.1), indicating that these results are representative of the population.
- The dataset was large enough. In small sample sizes, significant departures from normality can have a substantial impact on the results. For sufficiently large enough sample sizes approaching 200 or more, departures from normality have negligible effects (Hair et al., 2010, p. 72; Pallant, 2010, p. 56) as the "Central Limit Theorem ensures that the distribution of disturbance term will approximate normality" (Statistics Solutions, 2013).

5.3 Post-PCMS Survey Exploratory Factor Analysis

The pre-PCMS survey contained a 'PCTS' section comprised of ten survey items (E1–E10) that were included as measures of attitudes towards a generic PCTS. The EFA run on this section of the pre-PCMS survey in the pre-PCMS analysis resulted in a single factor that was labelled *Usage Intentions towards a PCTS*. The weighted factor score that measured *Usage Intentions towards a PCTS* was used as the dependent variable in the pre-PCMS analysis regression model that was described in Section 2.4.

With the exception of Survey Item E7 (*A PCT system would encourage me to eat more healthy, locally grown produce*), all the survey items that loaded on the *Usage Intentions towards a PCTS* factor in the pre-PCMS analysis were included in the post-PCMS survey; however, the survey item identifiers changed between surveys, some of the post-PCMS survey items were re-phrased to gather data specific to the NICHE PCMS as opposed to a generic PCTS, and some of the post-PCMS survey items were only answered by PCMS users as shown in Table 5-1 below.

Pre-PCMS Survey	Post-PCMS Survey	Post-PCMS respondents
E10. There is a strong link between a person's carbon footprint and their health.	D22. There is a strong link between a person's carbon footprint and their health.	All
E1. Being able to measure my carbon footprint is important to me.	F1. Being able to measure my carbon footprint is important to me.	All
E2. Most people would accept a PCT system as a tool for improving the environment.	F5. Most people would accept the NICHE carbon card system as a tool for improving the environment.	All
E5. People who reduce their carbon footprint should be rewarded in some way.	F7. People who reduce their carbon footprint should be rewarded in some way.	All
E6. People with a greater carbon footprint should have to pay for it in some way.	F8. People with a greater carbon footprint should have to pay for it in some way.	All
E3. A PCT system would encourage me to reduce my carbon footprint.	F18. The NICHE carbon card system has encouraged me to reduce my carbon footprint.	Only PCMS users
E4. A PCT system would encourage me to walk or cycle more and drive less.	F19. The NICHE carbon card system has encouraged me to walk or cycle more and drive less.	Only PCMS users
E8. A PCT system would be useful for me to help monitor my environmental impact.	F20. The NICHE carbon card system has helped me to monitor my environmental impact.	Only PCMS users
E9. Comparing my carbon usage to the average would influence my consumption habits.	F21. Comparing my household's carbon usage to the NICHE household average influenced my consumption habits.	Only PCMS users

Table 5-1 PCTS Survey Item Identifiers for the Pre-PCMS and Post-PCMS Surveys

Table 5-1 above shows that in the post-PCMS survey, survey Items D22, F1, F5, F7, and F8 were answered by *all* post-PCMS survey respondents. With the exception of Survey Item F5, the wording of these items remained unchanged in the post-PCMS survey. The remaining post-PCMS survey items (F18, F19, F20, and F21) listed in Table 5-1 above were all re-phrased to gather data specific to the NICHE PCMS as opposed to a generic PCTS and were only answered by PCMS users. The post-PCMS survey also contained two new survey items that were only answered by PCMS users and were included as additional measures of the usage behaviour of the NICHE PCMS. They are listed below with their post-PCMS survey identifiers:

- F17. Using the NICHE carbon card system has made me more aware of my carbon footprint; and
- F22. Comparing my household's carbon usage to the NICHE Target influenced my consumption habits.

Correlation analysis conducted on the post-PCMS dataset for the survey items that were answered by *all* post-PCMS survey respondents (D22, F1, F5, F7, and F8) identified that all but one of the relationships were significant (D22 and F7). The KMO was 0.717 and Bartlett's test of sphericity was significant ($p < 0.001$), thus confirming the suitability of the data for EFA. A single factor was sought that was labelled *Post-PCMS PCTS Attitudes* and explained 45.5% of the total variance among these items (see Appendix F.1). To allow for a more accurate comparison between the pre-PCMS and post-PCMS surveys later in the section, EFA was run on the pre-PCMS dataset for the corresponding pre-PCMS survey items (E1, E2, E5, E6 and

E10). The data was suitable for factor analysis (KMO = 0.769, $p < 0.001$) and a single factor was identified that explained 47.95% of the total variance among these items. The factor was labelled *Pre-PCMS PCTS Attitudes* (see Appendix F.5).

Correlation analysis run on the remaining post-PCMS dataset for the survey items (F17, F18, F19, F20, F21, and F22) listed above that were only answered by PCMS users, including the two new survey items, found that all relationships between these six variables were significant at the 99% confidence interval. The KMO was 0.773 and Bartlett's test of sphericity was significant ($p < 0.001$), thereby confirming the suitability of the data for factor analysis. EFA identified a single factor that was labelled *Usage Behaviour of the NICHE PCMS* and explained 72.7% of the total variance among these (see Appendix F.2).

The pre-PCMS survey contained an 'attitudes towards health, the environment, carbon emissions and climate change' section. This section was included in the post-PCMS survey, contained identical survey items, and used the same survey identifiers for the survey items. The EFA run on this section of the pre-PCMS survey for the pre-PCMS analysis that was described in Section 2.4 identified three factors (*Health Consciousness*, *Optimism*, and *Environmental Consciousness*). The EFA run on this section of the post-PCMS survey resulted in four factors that explained 63.4% of the variance among the items (KMO = 0.767, $p < 0.001$). However, factor loadings of less than $\pm$ 0.3 are considered less than minimal (Hair et al., 2010, p. 177) and, as can be seen in Table 5-2 below, the factor loading for Variable B3 (*Being overweight can have serious health effects*) was 0.262.

	Factor			
	1	2	3	4
B5	.784	.085	-.104	.194
B1	.773	-.008	.068	-.200
B7	.589	-.030	-.113	.368
B8	.552	.036	.283	-.154
B13	.376	.105	.087	.240
B4	-.038	.828	-.028	-.049
B2	.062	.493	.049	.054
B12	.015	.015	.713	-.136
B9	.008	.054	.689	.224
B3	.051	-.033	.262	.247
B11	.214	-.161	.218	.470
B6	-.010	.121	-.003	.445

Table 5-2 Pattern Matrix 1 for Attitudes towards Health, the Environment, Carbon Emissions, and Climate Change

Table 5-3 below shows that when Variable B3 was removed, the variance explained by the structures underlying these data items increased to 66.8% (KMO = 0.771, $p < 0.001$ [Appendix F.3]). Given that the variance explained has increased, the decision to remove Variable B3 from the analysis was justified.

	Factor			
	1	2	3	4
B1	.755	.022	.046	-.081
B5	.667	.086	-.082	.359
B8	.592	.060	.241	-.114
B4	-.031	.895	-.039	-.071
B2	.066	.460	.031	.071
B9	-.121	.009	.895	.247
B12	.137	.005	.555	-.134
B7	.462	-.039	-.078	.525
B6	-.082	.106	.034	.459
B11	.206	-.141	.189	.422
B13	.293	.071	.108	.320

Table 5-3 Pattern Matrix 2 for Attitudes towards Health, the Environment, Carbon Emissions, and Climate Change

The variables that loaded on the first factor were:

- B1. I buy environmentally friendly products as much as I can;
- B5. It is important for me to have a low carbon footprint; and
- B8. I always try to eat healthy food.

This factor was labelled *Consumer Consciousness* as these survey items measure an individual's proactive environmental, carbon, and health consumption behaviours.

The variables that loaded on the second factor were:

- B2. Technology will solve future environmental problems; and
- B4. Obesity will be solved in the future by medical advances.

As these survey items measure an individual's attitude that future technological advances could solve health and environmental problems, this factor was labelled *Technological Optimism*.

The variables that loaded on the third factor were:

- B9. I am confident I could maintain a healthy body weight if I wanted to; and
- B12. I am unlikely to ever be obese.

This factor was labelled *Body Weight Consciousness* as these survey items measure an individual's belief that they can maintain a healthy body weight.

The variables that loaded on the fourth factor were:

- B6. A financial incentive would encourage me to reduce my environmental impact;
- B7. Collectively, households can reduce the impacts of greenhouse gas emissions;
- B11. Walking or cycling instead of using the car can help reduce a person's weight; and
- B13. I am worried about climate change.

This factor was labelled *Carbon Consciousness* as these survey items measure an individual's attitudes towards carbon-neutral forms of transport, carbon emissions and climate change.

The pre-PCMS survey contained a ‘behaviours towards consumption and the environment’ section. This section was included in the post-PCMS survey and contained identical survey items, although the survey identifiers changed for all survey items in the post-PCMS survey. The pre-PCMS and post-PCMS survey identifiers are shown in Table 5-4 below.

Pre-PCMS	Post-PCMS	Survey Item
B14	B15	I turn the tap off when cleaning my teeth
B15	B16	I turn lights off when not in use
B16	B17	I sort my rubbish
B17	B18	I look to buy second hand over brand new
B18	B19	I consciously try to reduce waste and recycle
B19	B20	I buy local produce, even if imported is cheaper

Table 5-4 Behaviours towards Consumption and the Environment Survey Item Identifiers for the Pre-PCMS and Post-PCMS Surveys

The EFA run on this section of the pre-PCMS survey in the pre-PCMS analysis that was described in Section 2.4 resulted in a single factor (*Environmental Action*) that explained 47.5% of the variance among the items. The EFA (see Appendix F.4) run on this section of the post-PCMS survey also resulted in a single factor and the variance explained among the items has risen to 61.3% (KMO = 0.848, $p < 0.001$). The label *Environmental Action* was retained for this factor.

As was the case in the pre-PCMS survey, the post-PCMS survey did not have a dedicated ‘self-health evaluation’ section; however, the pre-PCMS and post-PCMS surveys both contained the following four identical survey items listed in Table 5-5 below to provide a basis to measure the self-reported health of the respondent. The survey identifiers for three of these survey items changed between surveys.

Pre-PCMS	Post-PCMS	Survey Item
A9	A8	Do you generally consider your health to be?
A10	A9	How would you best describe yourself?
A12	A11	Compared to others on the island of similar age and gender do you consider your body weight to be?
C1	C1	How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?

Table 5-5 Self-Health Evaluation Survey Item Identifiers for the Pre-PCMS and Post-PCMS Surveys

In Section 2.4, when the pre-PCMS analysis was discussed, it was explained that the scales used for the ‘self-health evaluation’ survey items made the data unsuitable for EFA as they were categorical. Nevertheless, as significant relationships were found in the pre-PCMS analysis between the variables, and there was an expectation of a relationship between the ‘self-health evaluation’ survey items and *Usage Intentions towards a PCTS*, the survey items in the ‘self-health evaluation’ section were entered into the pre-PCMS regression model as a single block that was labelled *Self-Health Evaluation*. *Self-Health Evaluation* was found to be a significant predictor of the *Usage Intentions towards a PCTS* in the pre-PCMS analysis. Given these results, these survey items were retained in a single block labelled *Self-Health Evaluation* in the post-PCMS analysis that follows to determine if this relationship has changed following the NICHE PCMS trial.

5.4 Post-PCMS Survey Regression Analysis

The following sections discuss the regression analysis that was conducted on the post-PCMS dataset to examine the three research questions. The minimum ratio of observations to independent variables in regression analysis is 5 to 1; however, it is recommended to have a minimum of 15–20 observations for each independent variable to ensure the results of regression analysis are generalisable (Hair et al., 2010, p. 175; Pallant, 2010, p. 148). Given the sample size of the post-PCMS dataset (N=176), a decision was made to use two regression models for the initial stages of the post-PCMS analysis. This was undertaken to ensure the recommended minimum ratio of observations for each independent variable in the models. The groups of variables that are included in the regression models introduced in this section were identified in the review of the technology acceptance literature (see Section 2.3.1) and the EFA that was run on the pre-PCMS survey dataset (see Section 2.4) and post-PCMS survey dataset (see Section 5.3).

The first stage of the post-PCMS regression analysis used the complete post-PCMS dataset (N=176) and the weighted factor score derived from the EFA in the previous section that was labelled *Post-PCMS PCTS Attitudes* as the dependent variable.

In the first regression model, the individual variables identified in the post-PCMS EFA as loading on to the factors listed below were entered as blocks of independent variables in the following order:

- Environmental Action;

- Consumer Consciousness; and
- Technological Optimism.

In the following discussion, this regression model is referred to as the **first post-PCMS model**.

In the second regression model, the individual variables identified in the post-PCMS EFA as loading on to the factors listed below were entered as blocks of independent variables in the following order:

- Body Weight Consciousness;
- Carbon Consciousness; and
- Self-Health Evaluation.

In the following discussion, this regression model is referred to as the **second post-PCMS model**.

To compare the changes in attitudes towards PCTS following the NICHE PCMS trial more accurately, the pre-PCMS analysis regression model was re-run using the weighted factor score described in the previous section that was labelled *Pre-PCMS PCTS Attitudes* as the dependent variable. This was carried out so that the weighted factor score that was used as the dependent variable in the pre-PCMS model and the weighted factor score that was used as the dependent variable in the first and second post-PCMS models would be comprised of similar survey items from their respective surveys. The complete pre-PCMS dataset with all responses (N = 423) was used. The individual variables from the pre-PCMS dataset that were described in Section 2.4 as loading on to the pre-PCMS factors listed below were entered as blocks of independent variables in the following order:

- Self-Health Evaluation;
- Health Consciousness;
- Environmental Action;
- Optimism; and
- Environmental Consciousness.

In the following discussion, the resulting regression model is referred to as the **pre-PCMS model**.

The pre-PCMS model is compared with the first post-PCMS model and the second post-PCMS model in Section 5.4.1 of this chapter to examine Research Question 1 (*What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?*).

The first post-PCMS model and the second post-PCMS model were further examined by moderating inputs by the Variable F10 (*Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?*) for PCMS users (N = 88) and non-PCMS users (N = 76). For identification purposes in the following discussion, these models are referred to as:

- First post-PCMS model for PCMS users;
- First post-PCMS model for non-PCMS users;
- Second post-PCMS model for PCMS users; and

- Second post-PCMS model for non-PCMS users.

On examination, it was found that the first post-PCMS model for non-PCMS users was not a significant predictor of *PCTS Attitudes* ($F(11, 29) = 1.963$, $p = 0.072$). The independent variable labelled *Technological Optimism* was removed from the model, and the model was re-run. The resulting first post-PCMS model for non-PCMS users was found to be a significant predictor of *PCTS Attitudes* ($F(9, 31) = 2.466$, $p = 0.030$) and was taken forward in the discussion that follows. These regression models for PCMS users and non-PCMS users are compared in Section 5.4.2 of this chapter to examine Research Question 2 (*What differences in attitudes towards PCTS will be evident between those who volunteered for the NICHE PCMS trial and those who did not?*).

The final stage of the regression analysis used the weighted factor score derived from the post-PCMS EFA in the previous section that was labelled *Usage Behaviour of the NICHE PCMS* as the dependent variable. All the regression models in this stage of the analysis were moderated by Variable F10 for PCMS users (N = 88). The first two regression models used the *Environmental Action*, *Consumer Consciousness*, *Technological Optimism*, *Body Weight Consciousness*, *Carbon Consciousness*, and *Self-Health Evaluation* blocks of variables identified in the post-PCMS EFA as the independent variables. The second two models used the blocks of variables that were included in the post-PCMS survey as measures of the six constructs identified from TAM2 and the literature (*Subjective Norm*, *Voluntariness*, *Cost*, *Perceived Usefulness*, *Perceived Ease of Use*, and *Intention to Use*) as the independent variables (see Section 3.3.4.4 for the survey items that each of these constructs are comprised of). The models in this stage of the analysis are discussed in Section 5.4.3 of this chapter to examine Research Question 3 (*What factors influenced the usage behaviour of the NICHE PCMS?*).

In the first model, the blocks of independent variables were entered in the following order:

- Environmental Action;
- Consumer Consciousness; and
- Technological Optimism.

In the following discussion, this regression model is referred to as the **first usage behaviour model**.

In the second model, the blocks of independent variables were entered in the following order:

- Body Weight Consciousness;
- Carbon Consciousness; and
- Self-Health Evaluation.

In the following discussion, this regression model is referred to as the **second usage behaviour model**.

In the third model, the blocks of independent variables were entered in the following order:

- Subjective Norm;
- Voluntariness; and
- Intention to Use.

In the following discussion, this regression model is referred to as the **third usage behaviour model**.

In the fourth model, the blocks of independent variables were entered in the following order:

- Cost;
- Perceived Ease of Use; and
- Perceived Usefulness.

In the following discussion, this regression model is referred to as the **fourth usage behaviour model**.

As previously noted, some of the individual variables that load onto the weighted factor scores that were used as the dependent variables in the models discussed in this section were only included in the post-PCMS survey. Others were reworded in the post-PCMS survey to gather data specific to the NICHE PCMS as opposed to a generic PCTS. Therefore, a statistical comparison of the factor weightings was not conducted. The statistically significant differences between the individual variables that loaded onto these factors can be seen in Chapter Four.

In the following sections of this chapter, the R squared change values (as percentages) are reported for all constructs in all models, along with the standardised beta coefficients (β) and unstandardised beta coefficient (*B*) for all individually significant variables to outline the amount of change predicted by these relationships. Table 5-6 below shows that all of the regression models described in this section were significant, and there was independence of residuals, as assessed by a Durbin-Watson statistic. Table 5-6 also provides the appendix where the full outputs of the regression analysis, including the total R squared and adjusted R squared values and the assumption testing for each model can be found.

Model Name	Significance	Durbin-Watson	Full Output
pre-PCMS model	$F(22, 300) = 8.937, p < 0.001$	1.828	Appendix G
first post-PCMS model	$F(11, 109) = 6.829, p < 0.001$	2.056	Appendix H
second post-PCMS model	$F(10, 105) = 7.355, p < 0.001$	2.163	Appendix I
first post-PCMS model for PCMS users	$F(11, 62) = 4.215, p < 0.001$	2.262	Appendix J
first post-PCMS model for non-PCMS users	$F(9, 31) = 2.466, p = 0.030$	1.691	Appendix K
second post-PCMS model for PCMS users	$F(10, 59) = 2.865, p = 0.006$	2.089	Appendix L
second post-PCMS model for non-PCMS users	$F(10, 29) = 5.063, p < 0.001$	1.812	Appendix M
first usage behaviour model	$F(11, 66) = 1.989, p = 0.044$	2.071	Appendix N
second usage behaviour model	$F(10, 63) = 2.493, p = 0.014$	1.914	Appendix O
third usage behaviour model	$F(6, 67) = 15.569, p < 0.001$	1.862	Appendix P
fourth usage behaviour model	$F(6, 68) = 10.590, p < 0.001$	1.628	Appendix Q

Table 5-6 Regression Analysis Significance and Durbin-Watson Statistic

For each of the models listed in Table 5-6 above:

- A visual inspection of a plot of standardised residuals versus standardised predicted values showed that there was homoscedasticity;
- A visual inspection of a normal probability plot showed that the residuals were normally distributed; and
- A visual inspection of a scatterplot showed that there was a linear relationship between the variables.

5.4.1 Changes in PCTS Attitudes

The pre-PCMS model, first post-PCMS model, and second post-PCMS model were introduced in the previous section. In this section, the pre-PCMS model is compared with the first post-PCMS model and the second post-PCMS model to examine Research Question 1 (*What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?*).

5.4.1.1 Model Summaries

The relationships and variances explained by the pre-PCMS model are summarised in Figure 5-1 below. The relationships and variance explained by the first post-PCMS model and the second post-PCMS model are summarised in Figure 5-2. The R squared values (as percentages) and standardised beta coefficients (β) are included for all models. The survey item identifiers for some of the survey items discussed in this section changed between the pre-PCMS and post-PCMS surveys. To allow a comparison of the models more accurately, Table 5-7 below shows the post-PCMS survey item identifiers that changed between surveys with their corresponding pre-PCMS survey item identifiers.

Pre-PCMS	A9	A10	A12	B14	B15	B16	B17	B18	B19
Post-PCMS	A8	A9	A11	B15	B16	B17	B18	B19	B20

Table 5-7 Survey Item Identifiers that Changed between the Pre-PCMS and Post-PCMS Surveys

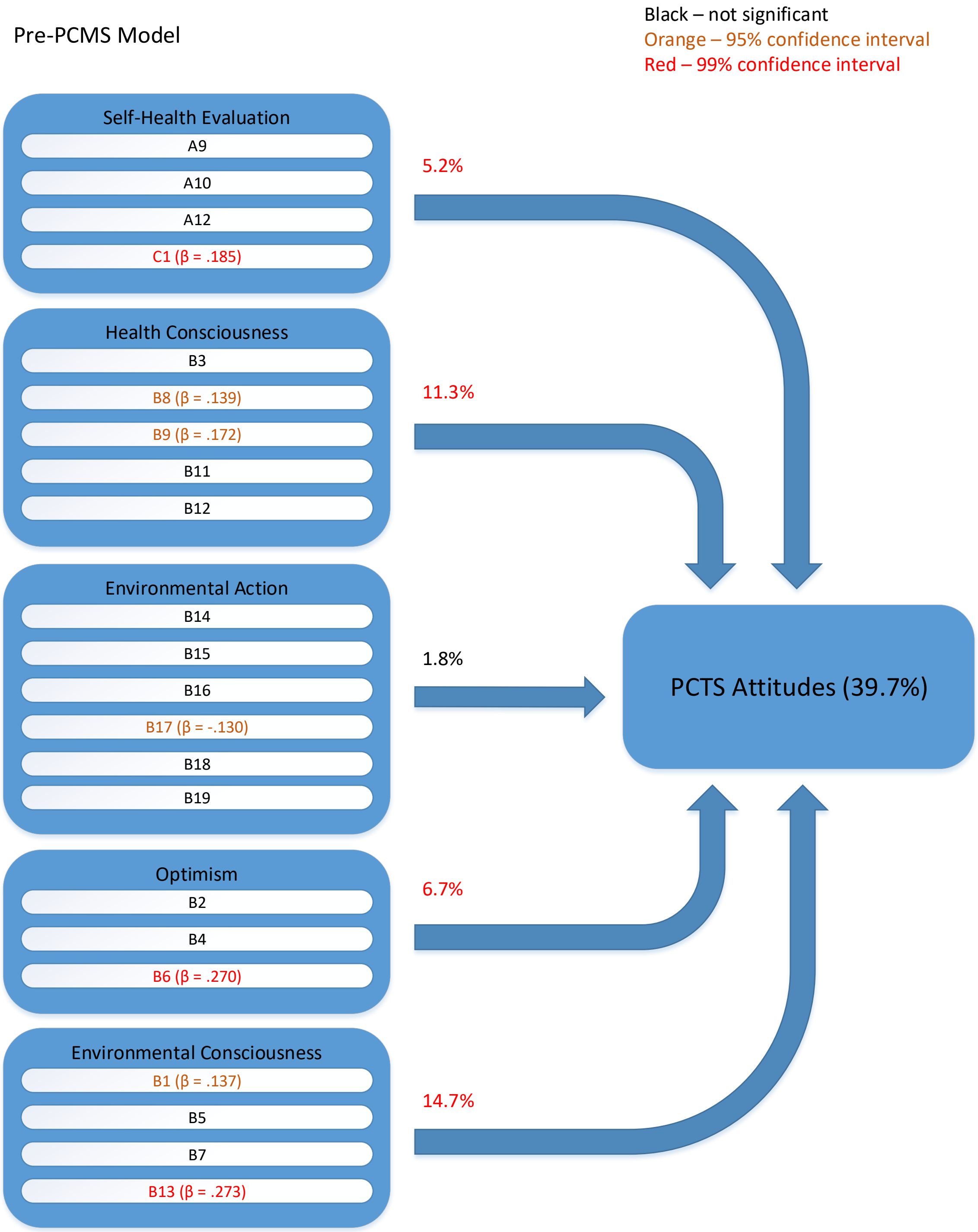

Figure 5-1 Pre-PCMS Model

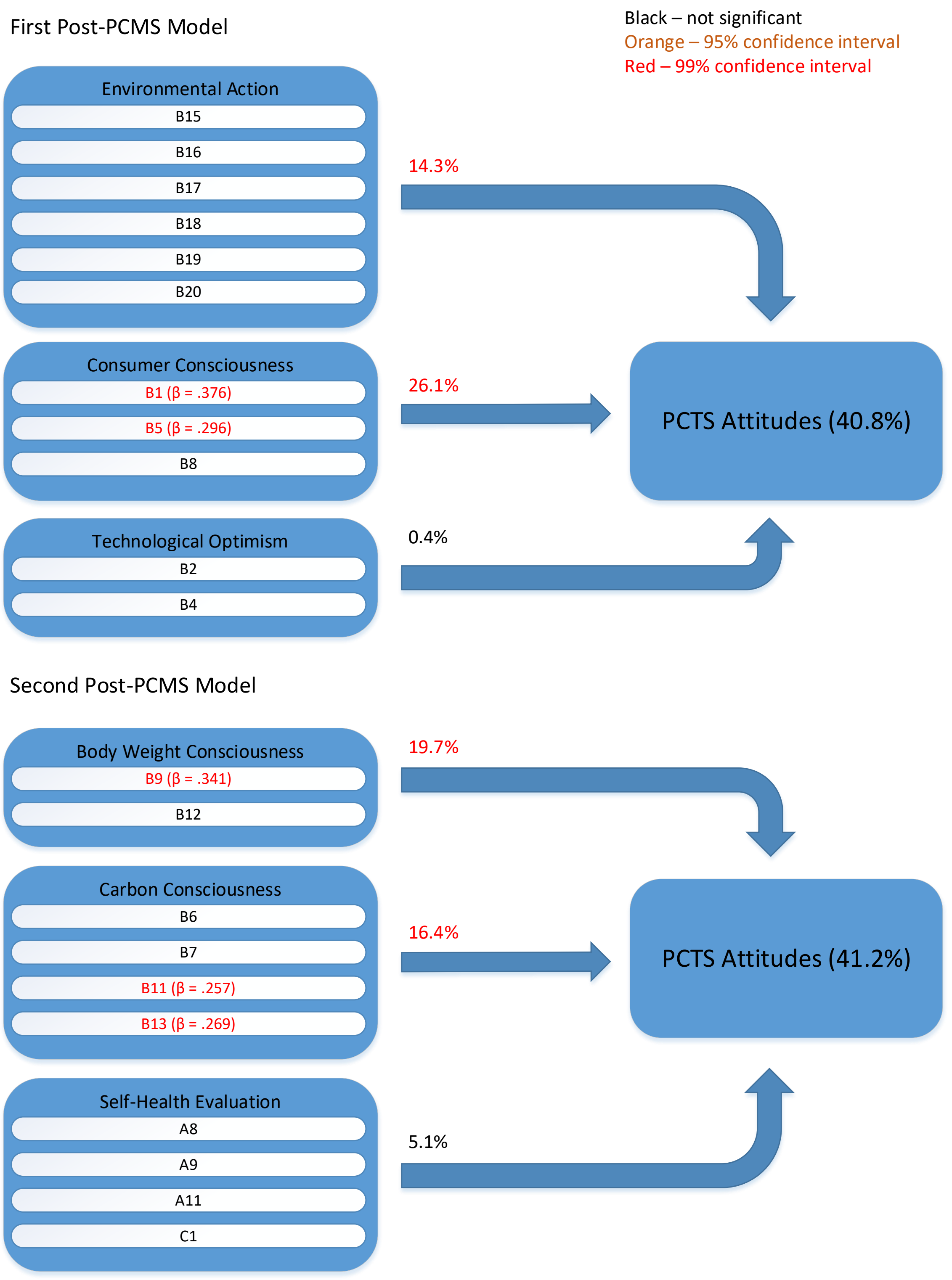

Figure 5-2 First Post-PCMS Model and Second Post-PCMS Model

Individual variables that were significant contributing factors in Figure 5-1 and Figure 5-2 above are listed in Table 5-8 below along with their unstandardised beta coefficient (*B*) to outline the amount of change predicted by these relationships.

Variable block	Survey Item	Unstandardised Beta Coefficient
Pre-PCMS model		
Self-health Evaluation	C1. How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?	0.120
Health Consciousness	B8. I always try to eat healthy food.	0.102
Health Consciousness	B9. I am confident I could maintain a healthy body weight if I wanted to.	0.120
Environmental Action	B17. I look to buy second hand over brand new.	-0.066
Optimism	B6. A financial incentive would encourage me to reduce my environmental impact.	0.140
Environmental Consciousness	B1. I buy environmentally friendly products as much as I can.	0.091
Environmental Consciousness	B13. I am worried about climate change.	0.155
First post-PCMS model		
Consumer Consciousness	B1. I buy environmentally friendly products as much as I can.	0.207
Consumer Consciousness	B5. It is important for me to have a low carbon footprint.	0.194
Second post-PCMS model		
Body Weight Consciousness	B9. I am confident I could maintain a healthy body weight if I wanted to.	0.205
Carbon Consciousness	B11. Walking or cycling instead of using the car can help reduce a person's weight.	0.188
Carbon Consciousness	B13. I am worried about climate change.	0.142

Table 5-8 Individual Variables that were Significant Contributing Factors to PCTS Attitudes – Pre-PCMS and Post-PCMS Analysis

5.4.1.2 Model Discussion

The pre-PCMS model in Figure 5-1 above shows that the five blocks of independent variables predicted 39.7% of the total variance in *PCTS Attitudes*. The first and second post-PCMS models in Figure 5-2 above show that the variance explained in the post-PCMS regression analysis has risen, with 40.8% and 41.2% of the total variance in *PCTS Attitudes* predicted by each model respectively. The main differences between the models are discussed in the following paragraphs.

The pre-PCMS model and the second post-PCMS model both had a block of variables that was labelled *Self-Health Evaluation*, which was comprised of the same individual variables from their respective surveys. In both models, this block of variables explained almost identical levels of variance (5.1% and 5.2% respectively). Yet, while this block of variables was significant in the pre-PCMS model, it was not significant in the second post-PCMS model. The *Self-Health Evaluation* block in the pre-PCMS model also contained the individually significant Variable C1 (*How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?* [$p = 0.001$, $\beta = 0.185$, $B = 0.120$]) that was not significant in the second post-PCMS model.

The second health-related block of variables in the pre-PCMS model was *Health Consciousness*. This block was significant and explained 11.3% of the variance. Two of the individual variables from the *Health Consciousness* block made up the significant *Body Weight Consciousness* block of variables in the second post-PCMS model. The variance explained by *Body Weight Consciousness* rose to 19.7% in the second post-PCMS model. The *Health Consciousness* and *Body Weight Consciousness* blocks contained Variable B9 (*I am confident I could maintain a healthy body weight if I wanted to*) that was individually significant in the pre-PCMS model (p = 0.022, β = 0.270, B = 0.120) and the second post-PCMS model (p = 0.001, β = 0.341, B = 0.205), although the increase in the unstandardised beta coefficient in the post-PCMS model indicates that Variable B9 was a greater predictor of *PCTS Attitudes* following the NICHE PCMS trial. However, the *Health Consciousness* block of variables in the pre-PCMS model contained the individually significant Variable B8 (*I always try to eat healthy food* [p = 0.030, β = 0.139, B = 0.102]) that was not significant in the post-PCMS model.

That these health-related blocks of variables are significant in the pre-PCMS and post-PCMS analysis is of note. The review of the literature identified that there is a relationship between health, obesity, carbon emissions, and climate change. Nevertheless, the review of literature did not identify any research into the relationship between health, body weight, and PCTS outside of the publications emanating from the NICHE project. Given the significance of these health-related blocks of variables in the pre-PCMS and post-PCMS regression analysis, it is clear that there is a relationship between attitudes towards health and body weight and attitudes towards PCT, although it does not appear that there has been much change in this relationship following the NICHE PCMS trial. While there has been an increase in the variance explained by *Body Weight Consciousness* and an increase in the unstandardised beta coefficient for Variable B9 (*I am confident I could maintain a healthy body weight if I wanted to*), the *Self-Health Evaluation* block and other individual variables that were significant in the pre-PCMS analysis are no longer significant in the post-PCMS analysis.

The pre-PCMS model and the first post-PCMS model both had a block of variables labelled *Environmental Action* that measured an individual’s environmental behaviours and was comprised of the same individual variables from their respective surveys. This block of variables was not significant in the pre-PCMS model and only predicted 1.8% of the variance. In the pre-PCMS analysis that was conducted for the candidates Master of Business, *Environmental Action* was only a significant predictor of *Usage Intentions towards a PCTS* for individuals who believed that they had a lower than average carbon footprint (Hendry, 2014, p. 169). At the time, it was thought that this might be attributable to the ‘value-action gap’, or the environmental actions of the vast majority of Norfolk Islanders for financial reason, as opposed to environmental reasons. Yet, this block of variables was significant in the first post-PCMS model and predicted 14.3% of the variance. The significance and increase in variance explained by the *Environmental Action* block of variables in the first post-PCMS model indicates that the relationship between an individual’s environmental behaviours and their attitudes towards PCTS has changed following the NICHE PCMS trial. This will be investigated further in the next section to see if *Environmental Action* was a significant predictor for PCMS users and non-PCMS users.

The highest level of variance in the pre-PCMS model was explained by the *Environmental Consciousness* block of variables (14.7%). This block measured attitudes towards the environment, carbon emissions and climate change. The EFA that was run on the post-PCMS dataset resulted in two factors that contained measures of attitudes towards the environment, carbon emissions and climate change. These factors were labelled *Consumer Consciousness* and *Carbon Consciousness*. The variance explained by these blocks in their respective post-PCMS regression models has increased to 16.4% for *Carbon Consciousness* and 26.1% for *Consumer Consciousness*.

From these blocks of variables, the following individual variables were significant in the pre-PCMS and post-PCMS survey regression analysis:

- B1. I buy environmentally friendly products as much as I can:
    - *Environmental Consciousness* in the pre-PCMS model ($p = 0.002$, $\beta = 0.137$, $B = 0.091$); and
    - *Consumer Consciousness* in the first post-PCMS model ($p < 0.001$, $\beta = 0.376$, $B = 0.207$).
- B13. I am worried about climate change:
    - *Environmental Consciousness* in the pre-PCMS model ($p < 0.001$, $\beta = 0.273$, $B = 0.155$); and
    - *Carbon Consciousness* in the second post-PCMS model ($p = 0.004$, $\beta = 0.296$, $B = 0.142$).

That worry about climate change was a significant predictor of *PCTS Attitudes* in the pre-PCMS and post-PCMS analysis is understandable given that a PCTS is a tool designed to limit climate change through the mitigation of carbon emissions;

however, there has not been much change in the unstandardised beta coefficient between surveys for Variable B13, indicating that the relationship between worry about climate change and attitudes towards PCT has not changed following the NICHE PCMS trial. In comparison, the unstandardised beta coefficient for Variable B1 (*I buy environmentally friendly products as much as I can*) has more than doubled in the first post-PCMS model and is larger than that of any other individually significant variable from all of the regression models discussed in this section. This outcome predicts that on a 7-point Likert-type scale, *PCTS Attitudes* would increase by 0.207 for each 1-point increase in attitudes towards buying environmentally friendly products as much as possible following the NICHE PCMS trial. Possible reasons for the change in the relationship between buying environmentally friendly products and PCT attitudes are discussed at the end of this section.

The *Consumer Consciousness* and *Carbon Consciousness* blocks of variables in the post-PCMS survey regression models also contained the following individually significant variables that were not significant in the pre-PCMS model:

- B5. It is important for me to have a low carbon footprint – *Consumer Consciousness* in the first post-PCMS model (p = 0.002, β = 0.296, B = 0.194); and
- B11. Walking or cycling instead of using the car can help reduce a person's weight – *Carbon Consciousness* in the second post-PCMS model (p = 0.006, β = 0.257, B = 0.188).

Given the function of a PCTS in limiting carbon emissions, it is also no surprise that Variable B5, which measured an individual's attitude towards the importance of having a low carbon footprint, was significant in predicting *PCT Attitudes*. That it was significant in the second post-PCMS model when it was not significant in the pre-PCMS model raises questions that are discussed in the following paragraph.

That there were similarities between the pre-PCMS and post-PCMS models is to be expected. The models represent different stages of the same research project targeting the same sample population. Therefore, similarities in attitudes could be expected regardless of the impact of the rollout of the NICHE PCMS. However, it is evident that there has been a shift in attitudes represented by the increased variance across the significant blocks of variables with an 'environmental' focus in the post-PCMS analysis. When compared with the *Environmental Consciousness* block of variables in the pre-PCMS model, the variance explained by *Carbon Consciousness* has increased, and the variance explained by *Consumer Consciousness* has almost doubled in the post-PCMS models. The post-PCMS models also contained additional individually significant variables within these blocks that were not significant in the pre-PCMS model. The *Environmental Action* block of variables was not significant in the pre-PCMS model, yet it is significant in the first post-PCMS model. It was reported in Section 4.3.3 that there had been a positive shift in attitudes towards the environment, carbon emissions, and climate change in the post-PCMS survey, with all but one survey item included in the comparison seeing a significant rise in levels of agreement. The results in this section highlight that these environmental attitudes and behaviours are also greater predictors of *PCTS Attitudes* in the post-PCMS analysis.

While it is possible attitudes towards the environment, carbon emissions, and climate change have occurred independently of the NICHE PCMS trial, it is likely that these changes are at least in part due to the changing attitudes of PCMS-users as a result of the NICHE PCMS trial. In Section 4.6, it was reported that the majority of the PCMS users who completed the post-PCMS survey agreed with the following survey items:

- F13. It was easy to use the NICHE carbon card at the petrol station (85.2% agreed, 6.8% disagreed);
- F14. It has been a valuable use of my time to review the size of my household's carbon footprint (67.1% agreed, 5.9% disagreed);
- F16. The information about my household's carbon footprint provided by the NICHE carbon card system was very useful (60.7% agreed, 6% disagreed);
- F17. Using the NICHE carbon card system has made me more aware of my carbon footprint (76.2% agreed, 4.8% disagreed);
- F18. The NICHE carbon card system has encouraged me to reduce my carbon footprint (67.1% agreed, 6.1% disagreed);
- F20. The NICHE carbon card system has helped me to monitor my environmental impact (58.3% agreed, 10.7% disagreed); and
- F23. If it was still available, I would continue to use the NICHE carbon card system to monitor my personal carbon footprint (61.9% agreed, 10.7% disagreed).

The responses to these survey items suggest that the NICHE PCMS trial and increased awareness of their household's carbon emissions had a positive influence on attitudes towards the environment and carbon emissions for PCMS users. This could explain the positive shift in attitudes towards the environment, carbon emissions, and climate change reported in Section 4.3.3, and the increased variance in *PCTS Attitudes* predicted by the blocks of variables with an 'environmental' focus following the NICHE PCMS trial. It could also explain the significant increase in the percentage of respondents who agreed with Survey Item F5 (*Most people would accept the NICHE carbon card system as a tool for improving the environment*) in the post-PCMS survey when PCT attitudes were compared in Section 4.3.2. This is explored further in the next section when the post-PCMS models are moderated by NICHE PCMS usage for PCMS users and non-PCMS users.

5.4.2 PCMS Users vs Non-PCMS users

Section 4.5.2 of the previous chapter highlighted that PCMS users were significantly more likely to register positive attitudes toward PCT than non-PCMS users. PCMS users were also significantly more likely to believe in anthropogenic climate change than non-PCMS users. To further examine Research Question 2 (*What differences in attitudes towards PCTS will be evident between those who volunteered for the NICHE PCMS trial and those who did not?*), the first post-PCMS model and the second post-PCMS model from the previous section were moderated by the Variable F10 (*Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?*) for PCMS users (N = 88) and non-PCMS users (N =

76). The resulting models were introduced in Section 5.4 of this chapter and are referred to as the:

- First post-PCMS model for PCMS users;
- First post-PCMS model for non-PCMS users;
- Second post-PCMS model for PCMS users; and
- Second post-PCMS model for non-PCMS users.

The dependent variable in the models was the weighted factor score derived from the post-PCMS EFA in Section 5.3 of this chapter that was labelled *Post-PCMS PCTS Attitudes*. The variables that loaded on this factor were listed in that section.

5.4.2.1 Model Summaries

The model summaries for the four models have been combined into Figure 5-3 below to more easily enable comparisons. The R squared values (as percentages) and standardised beta coefficients (β) are included for all models.

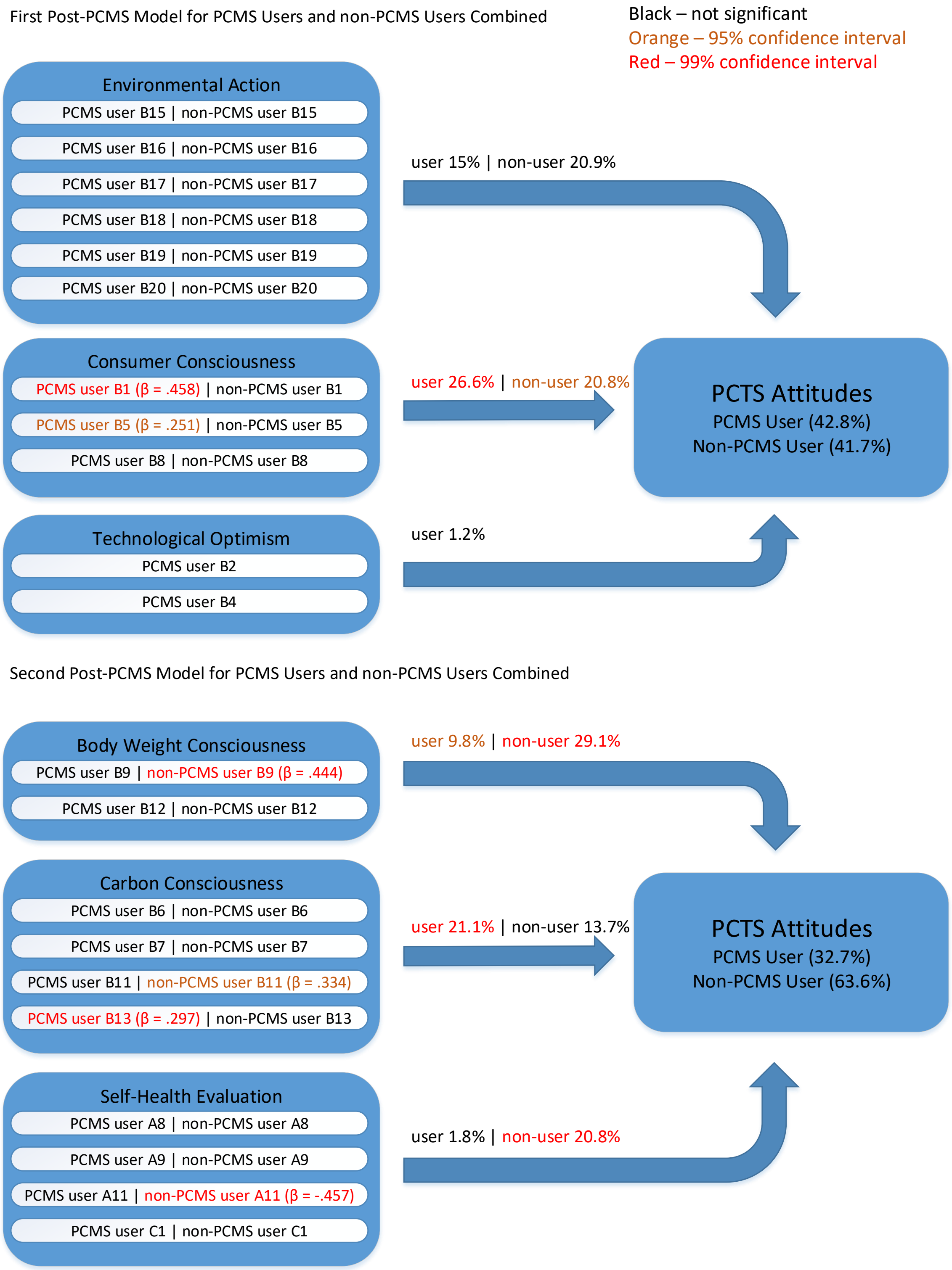

Figure 5-3 First and Second Post-PCMS Model for PCMS Users and Non-PCMS users

Individual variables that were significant contributing factors in Figure 5-3 above are listed in Table 5-9 below along with their unstandardised beta coefficient (*B*) to outline the amount of change predicted by these relationships.

Variable block	Survey Item	Unstandardised Beta Coefficient
First post-PCMS model for PCMS users		
Consumer Consciousness	B1. I buy environmentally friendly products as much as I can.	0.240
Consumer Consciousness	B5. It is important for me to have a low carbon footprint.	0.165
Second post-PCMS model for PCMS users		
Carbon Consciousness	B13. I am worried about climate change.	0.153
Second post-PCMS model for non-PCMS users		
Body Weight Consciousness	B9. I am confident I could maintain a healthy body weight if I wanted to.	0.208
Carbon Consciousness	B11. Walking or cycling instead of using the car can help reduce a person's weight.	0.197
Self-Health Evaluation	A11. Compared to others on the island of similar age and gender, do you consider your body weight to be?	-0.517

Table 5-9 Individual Variables that were Significant Contributing Factors to PCTS Attitudes – PCMS Users and Non-PCMS users

5.4.2.2 Model Discussion

Figure 5-3 shows that almost identical levels of variance in *PCTS Attitudes* were predicted in the first post-PCMS model for PCMS users (42.8%) and the first post-PCMS model for non-PCMS users (42.7%). In both models, the only significant block of variables was *Consumer Consciousness*. However, the total variance in *PCTS Attitudes* explained by the second post-PCMS model for non-PCMS users (63.6%)

was almost twice that explained by the second post-PCMS model for PCMS users (32.7%). While *Body Weight Consciousness* was a significant predictor in both models, *Carbon Consciousness* was only significant in the second post-PCMS model for PCMS users, while *Self-Health Evaluation* was only significant in the second post-PCMS model for non-PCMS users.

That *Consumer Consciousness* was a significant predictor of *PCTS Attitudes* in the first post-PCMS model for PCMS users and the first post-PCMS model for non-PCMS users is not surprising given that it contained measures of proactive environmental and carbon emission behaviours. It is reasonable to assume that an individual's proactivity towards these behaviours would have a relationship with their attitudes towards PCTS. However, a larger amount of variance was predicted by *Consumer Consciousness* in the model for PCMS users (26.6%) than in the model for non-PCMS users (20.8%). The model for PCMS users also contained the following individually significant variables that were not significant in the model for non-PCMS users:

- B1. I buy environmentally friendly products as much as I can (p = 0.002, β = 0.458, B = 0.240); and
- B5. It is important for me to have a low carbon footprint (p = 0.035, β = 0.251, B = 0.165).

In Section 4.5.3, it was shown that there was no significant difference in the responses for PCMS users and non-PCMS users for either of the survey items listed above. Yet, these results suggest that buying environmentally friendly products and the importance of having a low carbon footprint were only significant predictors of the *PCTS Attitudes* for PCMS users. It is not surprising that the importance of having a low carbon footprint was significant in the model for PCMS users, given they voluntarily used the NICHE PCMS to monitor their carbon footprint. In the previous section, it was reported that Variable B1 (*I buy environmentally friendly products as much as I can*) had the largest unstandardised beta coefficient of any of the individually significant variables. In the models discussed in this section, Variable B1 had the largest unstandardised beta coefficient for PCMS users and the second-largest overall. In the literature review, it was shown that the value-action gap is especially prevalent for environmental attitudes and behaviours. Buying environmentally friendly products as often as possible is an indication that an individual's environmental attitudes reliably translate into environmental behaviours, as is voluntary PCMS usage. This might explain why any change in the levels of agreement to this survey item would result in the most substantial change in *PCTS Attitudes* for PCMS users.

The *Carbon Consciousness* block of variables was significant in the second post-PCMS model for PCMS users but not in the second post-PCMS model for non-PCMS users. In the model for PCMS users, this block of variables that measured attitudes towards carbon-neutral forms of transport, carbon emissions, and climate change predicted 21.1% of the variance in *PCTS Attitudes*. It also contained the individually significant Variable B13 (*I am worried about climate change* [$p = 0.011$, $\beta = 0.297$, $B = 0.153$]). It was shown in Section 4.5.3 that 81.6% of PCMS users agreed that they are worried about climate change. These results show that this worry was a significant predictor of their *PCTS Attitudes* and may explain in part why they voluntarily participated in the NICHE PCMS trial. It must be noted that while the *Carbon Consciousness* block of variables was not significant in the model for non-PCMS users, it did contain the individually significant Variable B11 (*Walking or cycling instead of using the car can help reduce a person's weight* [p = 0.040, β = 0.344, B = 0.197]). While this variable loaded on the *Carbon Consciousness* factor and is questioning the user about their attitudes towards active transport, this survey item is also asking the user about the health-related benefits of active transport. This will be discussed further in this section when the results for the 'health' related blocks of variables (*Body Weight Consciousness* and *Self-Health Evaluation*) are discussed.

In the first post-PCMS model with no moderating inputs that was discussed in the previous section, the *Environmental Action* block of variables that measured an individual's environmental behaviours was significant. However, in the first post-PCMS model for PCMS users and the first post-PCMS model for non-PCMS users, *Environmental Action* was no longer significant. It must be noted that the first post-PCMS model with no moderating inputs from the previous section also contained responses from individuals who selected *I didn't have a NICHE carbon card, but somebody else in this household did* for Survey Item F10 (*Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?*) and this could account for the significance of *Environmental Action* in the model. The *Environmental Action* block of variables will be investigated further in the next section when the factors that influenced the usage of the NICHE PCMS are examined.

In the second post-PCMS model for PCMS users and the second post-PCMS model for non-PCMS users, the *Body Weight Consciousness* block of variables was significant, although much higher levels of variance were predicted in the model for non-PCMS users (29.1%) than in the model for PCMS users (9.8%). The model for non-PCMS users also contained the individually significant Variable B9 (*I am confident I could maintain a healthy body weight if I wanted to* [$p = 0.008$, $\beta = 0.444$, $B = 0.208$]), whereas there were no individually significant variables in this block in the model for PCMS users. When the responses to this survey item were analysed in Section 4.5.4, no significant difference was found between PCMS users than non-PCMS users. Yet for PCMS users, this belief was not significant in predicting their *PCTS Attitudes*.

The other health-related block of variables, *Self-Health Evaluation*, was not significant in the second post-PCMS model for PCMS users and only explained 1.8% of the total variance in the model. In the second post-PCMS model for non-PCMS users, this block was significant and predicted 20.8% of the variance. It also contained the individually significant Variable A11 (*Compared to others on the island of similar age and gender, do you consider your body weight to be* [$p = 0.002$, $\beta = -0.457$, $B = -0.517$]). This variable had the largest unstandardised beta coefficient of any of the significant individual variables discussed in this section and indicates that for non-PCMS users, *PCTS Attitudes* would increase 0.517 for each 1-point decrease Variable A11. The decrease for Variable A11 is the result of the 5-point Likert-type scale used, with 1 being *well below average,* 3 being *average*, and 5 being *well above average,* meaning that *PCTS Attitudes* would increase for those who consider themselves to have a lower than average body weight.

While the *Body Weight Consciousness* and *Self-Health Evaluation* blocks of variables are both ‘health’ related, there are fundamental differences. The *Self-Health Evaluation* block of variables measured an individual’s evaluation of their own health, while the *Body Weight Consciousness* block of variables measured an individual’s confidence that they can always maintain a healthy body weight. It is possible for an individual to be proactive about their body weight while having poor health on account of age, sickness, or other factors. Conversely, it is also possible that an individual may be in good health but not be proactive about maintaining a healthy body weight. The results for the two ‘health’ related blocks of variables show that the *PCTS Attitudes* of PCMS users were predicted in part by the respondent’s proactivity towards maintaining a healthy body weight (*Body Weight Consciousness*) but not their actual health (*Self-Health Evaluation*). For non-PCMS users, *PCTS Attitudes* were predicted by the respondent’s proactivity towards maintaining a healthy body weight (*Body Weight Consciousness*) as well as their actual health (*Self-Health Evaluation*).

The results in this section highlight the differences in the significant predictors of *PCTS Attitudes* of PCMS users and non-PCMS users. While the *Body Weight Consciousness* block of variables was significant in the second post-PCMS model for PCMS users, the levels of variance predicted were small, and there were no individually significant variables. In contrast, much higher levels of variance were explained in the models for PCMS users by the blocks of variables with an 'environmental' focus, and there were several individually significant variables from these blocks. For non-PCMS users, the opposite is true. While *Consumer Consciousness* was significant in the first post-PCMS model for non-PCMS users, it did not have any individually significant variables. Much higher levels of variance were predicted by the blocks of variables with a 'health' focus and with a single exception, all the individually significant variables for non-PCMS users came from the 'health' related blocks. The exception, Variable B11 (*Walking or cycling instead of using the car can help reduce a person's weight*), from the *Carbon Consciousness* block of variables, questioned the user on attitudes towards weight loss associated with active transport, therefore has a 'health' component. Further to this, every individually significant variable in the models for non-PCMS users was related to body weight, highlighting that attitudes towards body weight were particularly important in predicting the *PCTS Attitudes* of non-PCMS users.

Section 4.5.3 of the previous chapter showed that there were no significant differences in attitudes towards the environment, carbon emissions, and climate change, and attitudes towards health, for PCMS users and non-PCMS users. Despite this, these results show that there were substantial differences in how these attitudes predicted the *PCTS Attitudes* of PCMS users and non-PCMS users. For PCMS users, much greater levels of variance in *PCTS Attitudes* were predicted by their attitudes towards the environment, carbon emissions, and climate change. In contrast, much greater levels of variance in the *PCTS Attitudes* of non-PCMS users were predicted by their attitudes towards health, and in particular their attitudes towards body weight. Though further research is required before these results could be extrapolated to the broader population, the findings reported here provide future researchers with a solid foundation to explore attitudes towards PCT in a larger population sample.

5.4.3 Usage Behaviour of the NICHE PCMS

The regression models discussed in this section are used to examine Research Question 3 (*What factors influenced the usage behaviour of the NICHE PCMS?*) and test the relationships in the proposed conceptual model. The following regression models were introduced in Section 5.4 of this chapter:

- First usage behaviour model;
- Second usage behaviour model;
- Third usage behaviour model; and
- Fourth usage behaviour model.

The dependent variable in all four models was the weighted factor score derived from the post-PCMS EFA in Section 5.3 of this chapter that was labelled *Usage Behaviour of the NICHE PCMS*. The variables that loaded on this factor were listed and described in that section.

All the models were moderated by the Variable F10 (*Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?*) for PCMS users (N = 88). In the following sections, the first and second usage behaviour models are discussed first, followed by the third and fourth usage behaviour models.

5.4.3.1 Constructs Identified from the EFA

5.4.3.1.1 Model Summaries

The relationships and variances explained by the first usage behaviour model and the second usage behaviour model are summarised in Figure 5-4 below. The R squared values (as percentages), and standardised beta coefficients (β) are also included for all models.

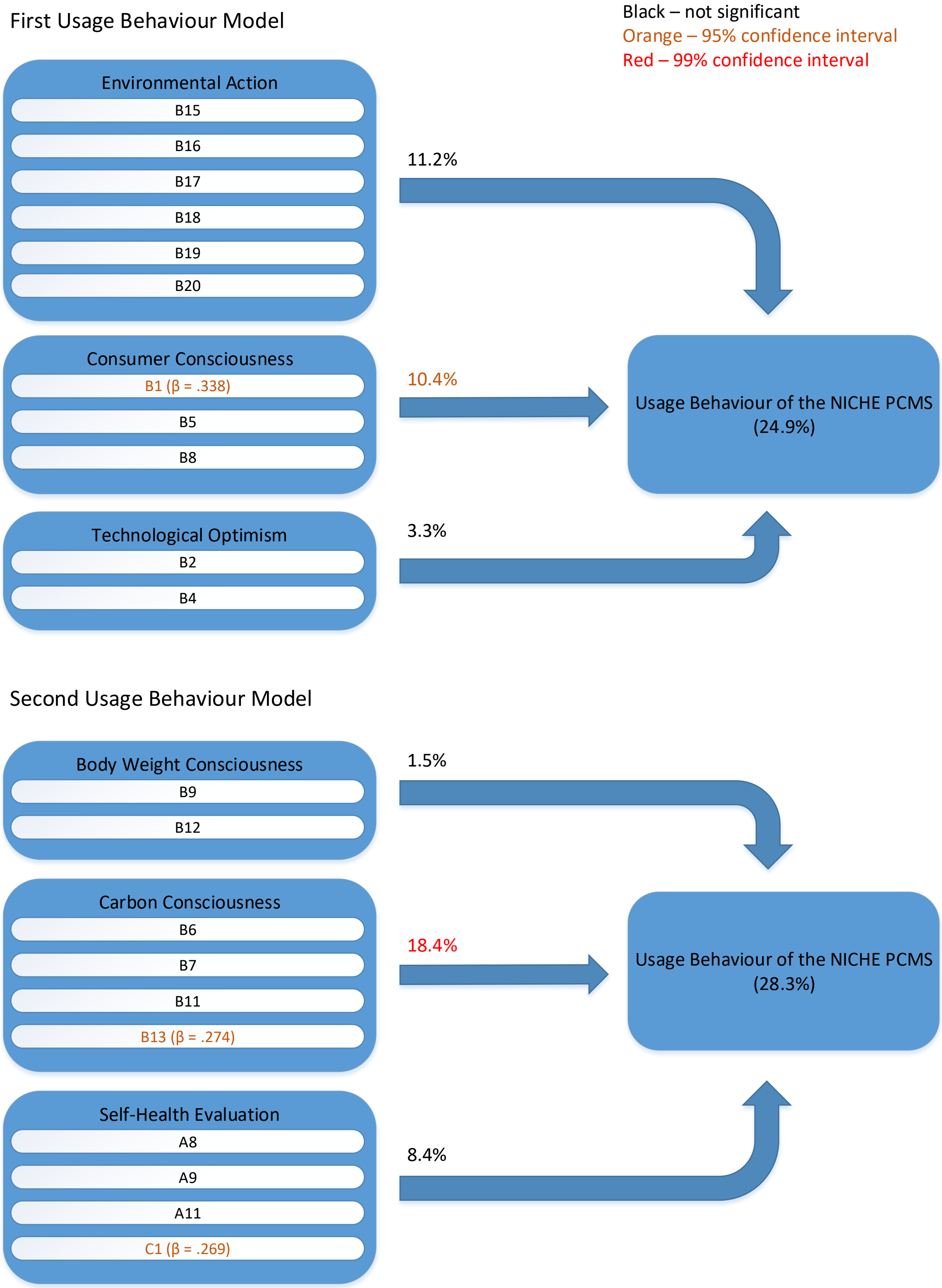

Figure 5-4 First and Second Usage Behaviour Model for PCMS Users

Individual variables that were significant contributing factors in Figure 5-4 above are listed in Table 5-10 below along with their unstandardised beta coefficient (*B*) to outline the amount of change predicted by these relationships.

Variable block	Survey Item	Unstandardised Beta Coefficient
First usage behaviour model		
Consumer Consciousness	B1. I buy environmentally friendly products as much as I can.	0.235
Second usage behaviour model		
Carbon Consciousness	B13. I am worried about climate change.	0.190
Self-Health Evaluation	C1. How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?	0.217

Table 5-10 Individual Variables that were Significant Contributing Factors to the Usage Behaviour of the NICHE PCMS – First and Second Usage Behaviour Models

5.4.3.1.2 Model Discussion

The regression analysis shows that 24.9% of the total variance in the *Usage Behaviour of the NICHE PCMS* was explained by the first usage behaviour model, and 28.3% of the total variance in the *Usage Behaviour of the NICHE PCMS* was predicted by the second usage behaviour model. However, only the *Consumer Consciousness* and *Carbon Consciousness* blocks of variables were significant.

The highest level of variance (18.4%) in either model was explained by *Carbon Consciousness*. The NICHE PCMS was designed to track carbon emissions and provide a reduction target to tackle the problem of climate change. Therefore, given that *Carbon Consciousness* contained measures of attitudes towards carbon-neutral forms of transport, carbon emissions, and climate change, it is not surprising that it was a significant predictor of the *Usage Behaviour of the NICHE PCMS* and explained the highest levels of variance. The Variable B13 (*I am worried about climate change* [p = 0.024, β = 0.274, B = 0.190]) from this block was also individually significant. It was expected that this individual variable would be a significant predictor as it is reasonable to assume that individuals who worry about climate change would be inclined to participate in a carbon monitoring trial.

The second significant block of variables, *Consumer Consciousness*, explained 10.4% of the total variance in the *Usage Behaviour of the NICHE PCMS*. Voluntary participation in a research trial like the NICHE PCMS is an example of a proactive behaviour towards limiting carbon emissions. Therefore, it is no surprise that the *Consumer Consciousness* block of variables that measured an individual's proactivity towards their environmental, carbon, and health consumption choices was a significant predictor. Variable B1 (*I buy environmentally friendly products as much as I can*) from this block was individually significant (p = 0.036, β = 0.338, B = 0.235) and had the largest unstandardised beta coefficient of any of the individual variables in either model. This individually significant variable indicates that on a 7-point Likert-type scale, the *Usage Behaviour of the NICHE PCMS* would increase 0.235 for each 1-point increase in the respondent's agreement that they buy environmentally friendly products as much as they can. Variable B1 also had the largest unstandardised beta coefficient in the models for PCMS users in the previous section, and it was discussed that buying environmentally friendly products as often as possible, and voluntary PCMS usage, are both indications that an individual's environmental attitudes reliably translate into environmental behaviours. The results from this section for Variable B1 highlight this and indicate that the value-action gap needs to be targeted in future research into PCTS/PCMS to identify what role it plays in voluntary usage of these systems.

As was the case in the previous section, the *Environmental Action* block of variables was not significant in the second usage behaviour model. NICHE researchers had hypothesised that the *Usage Behaviour of the NICHE PCMS* would be explained in part by the environmental behaviours of the PCMS users as it was expected that an individual who displays positive environmental actions would be motivated to use a system like the NICHE PCMS to effect environmental change. This is discussed further in Section 6.3.2. These findings warrant further research to see if this is unique to Norfolk Island or is indicative of a broader belief among individuals who would voluntarily use a technology like a PCMS.

While *Body Weight Consciousness* was significant in explaining the *PCTS Attitudes* of PCMS users, neither of the health-related block of variables (*Self-Health Evaluation* and *Body Weight Consciousness*) were significant in predicting the *Usage Behaviour of the NICHE PCMS*. However, the *Self-Health Evaluation* block of variables did contain the individually significant Variable C1 (*How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?* [$p = 0.027$, $\beta = 0.269$, $B = 0.217$]). This indicates that the *Usage Behaviour of the NICHE PCMS* was explained in part by the amount of time Norfolk Islanders engage in exercise to improve or maintain their health, whereas their evaluation of their actual health or their confidence in being able to maintain a healthy weight were not significant predictors. It is possible that an individual could be overweight or in poor health while actively trying to improve their health through physical activity. Alternatively, it is possible that an individual may be healthy but not engage in any physical activity to maintain their health. This significant variable suggests that being proactive about improving or maintaining health plays a part in predicting PCMS usage, as opposed to actual health or body weight. While not tested for in the current research, it may be that it is the proactive component that is important, and individuals who are proactive in this area are proactive across a range of other areas including mitigating carbon emissions, hence their voluntary participation in the NICHE PCMS trial.

That there were similarities between the *PCTS Attitudes* regression models for PCMS users discussed in the previous section and the *Usage Behaviour of the NICHE PCMS* models in this section was to be expected, as attitudes towards a PCT, and usage of a PCMS are related. The *Carbon Consciousness* and *Consumer Consciousness* blocks of variables were found to be significant predictors of the *PCTS Attitudes* for PCMS users and the *Usage Behaviour of the NICHE PCMS* and contained the same individually significant variables. Nevertheless, in the context of this research, there are slight differences, most notably among the 'health' related block of variables. While much greater levels of variance in the *PCTS Attitudes* of PCMS users were predicted by their environmental attitudes, the *Body Weight Consciousness* block of variables was significant; however, it was not significant in predicting the *Usage Behaviour of the NICHE PCMS.* In the next section, the *Usage Behaviour of the*

NICHE PCMS is further examined using additional blocks of variables that were included in the post-PCMS survey as measures of technology acceptance.

5.4.3.2 Constructs Identified from TAM

5.4.3.2.1 Model Summaries

The relationships and variances explained by the third usage behaviour model and the fourth usage behaviour model are summarised in Figure 5-5 below. The R squared values (as percentages) and standardised beta coefficients (β) are included for all models.

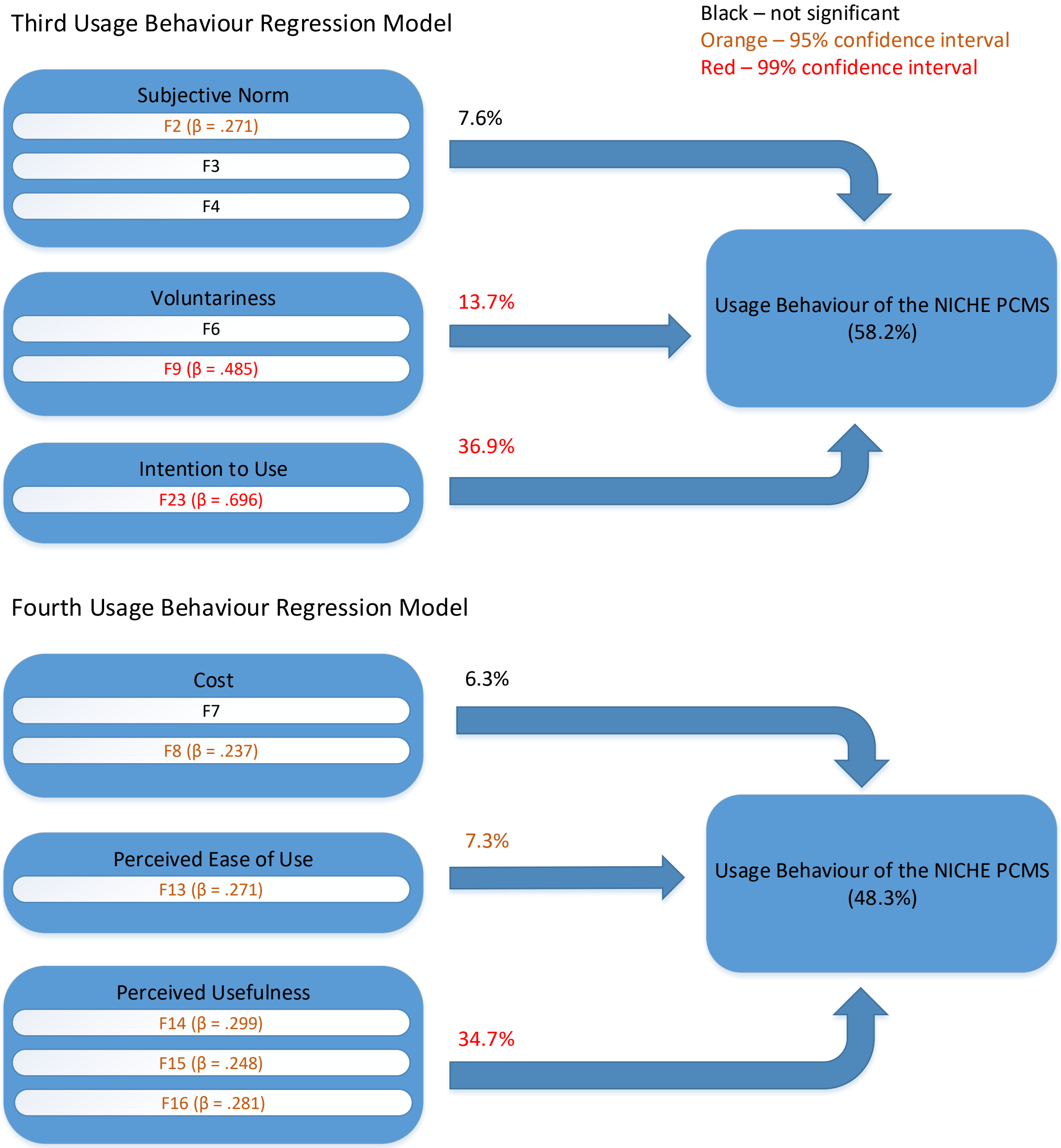

Figure 5-5 Third and Fourth Usage Behaviour Model for PCMS Users

Individual variables that were significant contributing factors in Figure 5-5 above are listed in Table 5-11 below along with their unstandardised beta coefficient (*B*) to outline the amount of change predicted by these relationships.

Variable block	Survey Item	Unstandardised Beta Coefficient
Third usage behaviour model		
Subjective Norm	F2. I was encouraged to use the NICHE carbon card system by my household.	0.146
Voluntariness	F9. I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island.	0.303
Intention to Use	F23. If it was still available, I would continue to use the NICHE carbon card system to monitor my personal carbon footprint.	0.456
Fourth usage behaviour model		
Cost	F8. People with a greater carbon footprint should have to pay for it in some way.	0.140
Perceived Ease of Use	F13. It was easy to use the NICHE carbon card at the petrol station.	0.160
Perceived Usefulness	F14. It has been a valuable use of my time to review the size of my household's carbon footprint.	0.212
Perceived Usefulness	F15. Being able to review information about the size of my carbon footprint has saved me money.	0.162
Perceived Usefulness	F16. The information about my households carbon footprint provided by the NICHE carbon card system was very useful.	0.196

Table 5-11 Individual Variables that were Significant Contributing Factors to the Usage Behaviour of the NICHE PCMS – Third and Fourth Usage Behaviour Models

5.4.3.2.2 Model Discussion

The model summaries above in Figure 5-5 above for the third usage behaviour model and the fourth usage behaviour model show that 58.2% and 48.3% of the total variance in the *Usage Behaviour of the NICHE PCMS* was predicted by each model respectively. In the third usage behaviour model, the *Voluntariness* and *Intention to Use* blocks of variables were significant, while in the fourth usage behaviour model, the *Perceived Ease of Use* and *Perceived Usefulness* blocks were significant.

The *Voluntariness* block of variables, which measured the extent to which individuals believe that use of carbon monitoring or trading systems should be compulsory, predicted 13.7% of the variance in the third usage behaviour model. This block contained the individually significant Variable F9 (*I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island* [p = 0.004, β = 0.485, B = 0.303]) that had the second-highest unstandardised beta coefficient of any of the individually significant variables in the model. While usage of the NICHE PCMS was voluntary, these results indicate that *Usage Behaviour of the NICHE PCMS* was partly predicted by the belief that usage of the system should be mandatory.

The other significant block in the third usage behaviour model, *Intention to Use*, predicted the highest level of variance (36.9%) in either of the models discussed in this section. Variable F23 (*If it was still available I would continue to use the NICHE carbon card system to monitor my personal carbon footprint* [p < 0.001, β = 0.696, B = 0.456]) was individually significant and had the highest unstandardised beta coefficient of any of the individually significant variables in this section. This was to be expected given that it is reasonable to assume that the decision to continue to use the NICHE PCMS if it was still available could be expected to predict user acceptance of the NICHE PCMS.

In the fourth usage behaviour model, the *Perceived Ease of Use* and *Perceived Usefulness* blocks of variables were significant. The significant individual Variable F13 (*It was easy to use the NICHE carbon card at the petrol station* [p = 0.017, β = 0.271, B = 0.160]) from *Perceived Ease of Use* measured how easy the NICHE PCMS point of sale was to use in the service stations. While 64.8% of PCMS users strongly agreed (option 1 on the 7-point Likert-type scale used for this question) and 20.5% agreed (option 2 or 3 on the 7-point Likert-type scale used for this question) that the system was easy to use this variable only explained 7.3% of the variance in *Usage Behaviour of the NICHE PCMS*. In contrast, the highest level of variance in the fourth usage behaviour model was explained by the significant *Perceived Usefulness* block of variables, which measured the degree to which the user believed that the system is useful. This block of variables predicted 34.7% of the total variance in *Usage Behaviour of the NICHE PCMS* and all three of the individual variables in the block were significant as follows:

- F14. It has been a valuable use of my time to review the size of my household's carbon footprint (p = 0.027, β = 0.299, B = 0.212);
- F15. Being able to review information about the size of my carbon footprint has saved me money (p = 0.024, β = 0.248, B = 0.162); and
- F16. The information about my household's carbon footprint provided by the NICHE carbon card system was very useful (p = 0.028, β = 0.281, B = 0.196).

These results indicate that *Perceived Usefulness* is a far more important predictor of the *Usage Behaviour of the NICHE PCMS* than *Perceived Ease of Use*. This is consistent with the technology acceptance literature that shows *Perceived Usefulness* is reliably found to be a strong determinant, whereas *Perceived Ease of Use* exhibits a less consistent effect (Venkatesh & Davis, 2000, p. 187). However, a hypothesis of TAM2 is that "perceived ease of use will have a positive effect on perceived usefulness" (Venkatesh & Davis, 2000, p. 192). Therefore, it is likely that the majority of PCMS users finding the system easy to use has contributed to the high level of variance explained by the *Perceived Usefulness* block of variables, despite *Perceived Ease of Use* not explaining much variance in the model. These results suggest that the usage and acceptance of the NICHE PCMS was driven by the perception that the system was useful in meeting the needs of PCMS users, while also being easy to use. This is an important finding for future researchers, governments, or lobbyists investigating PCTS/PCMS usage.

The *Cost* block of variables that measured the belief that there should be a cost for individuals with a high carbon footprint or a reward for individuals with a low carbon footprint was not significant. However, Variable F8 (*People with a greater carbon footprint should have to pay for it in some way* [$p = 0.050$, $\beta = 0.237$, $B = 0.140$]) from the *Cost* block was individually significant in predicting the *Usage Behaviour of the NICHE PCMS*. In comparison, Variable F7 (*People who reduce their carbon footprint should be rewarded in some way*) was not a significant ($p = 0.718$) predictor. This is highlighted by the fact that PCMS users were significantly more likely to agree with Variable F8 (*People with a greater carbon footprint should have to pay for it in some way*) than non-PCMS users (see Section 4.5.2). Yet there was no significant difference between PCMS users and non-PCMS users in their response to Variable F7 (*People who reduce their carbon footprint should be rewarded in some way*). The differences in responses between PCMS users and non-PCMS users for these survey items are discussed further in Section 6.3.3. In the discussion earlier in this section, the belief that usage of the NICHE PCMS should be mandatory was shown to be significant in predicting the *Usage Behaviour of the NICHE PCMS*. However, these results show that a belief in the mandatory use *and* a cost for carbon emissions, the central tenets of all the proposed PCT schemes, are predictors of the *Usage Behaviour of the NICHE PCMS*.

The *Subjective Norm* block of variables that measured the perceived social pressure to use the NICHE PCMS was not significant, although it contained the individually significant Variable F2 (*I was encouraged to use the NICHE carbon card system by my household* [p = 0.028, β = 0.271, B = 0.146]). This suggests that pressure from the community and the service station operators were not significant predictors of *Usage Behaviour of the NICHE PCMS*. However, some PCMS users were encouraged by their family members to participate in the NICHE PCMS trial, and this was a predictor of the *Usage Behaviour of the NICHE PCMS*. It must be noted that only *one* member of each household was requested to fill out the survey. Therefore, the attitudes and beliefs contained in the post-PCMS survey may not reflect the views held by other members of the household. Survey respondents were classed as PCMS users if they personally signed up for the NICHE PCMS trial. When asked about the causes of climate change, 23.5% of PCMS users reported that they believe climate change is a natural fluctuation in the earth's temperature. There would be little motivation for these individuals to voluntarily use a PCMS for the sole reason of limiting their carbon emissions, given they do not believe in anthropogenic climate change. When these individuals were asked whether they were encouraged to use the NICHE PCMS by their household, 70% agreed. This may explain the significance of this individual variable, and why these individuals who do not believe in anthropogenic climate change voluntarily took part in the NICHE PCMS trial. This is discussed further in Section 6.3.4.2.

5.4.3.3 Usage Behaviour of the NICHE PCMS Summary

The findings in this section show that the *Usage Behaviour of the NICHE PCMS* was predicted by the following significant blocks of variables, and in particular, the significant individual variables contained within each of the blocks:

In the first regression model:

- *Consumer Consciousness* predicted 10.4% of the total variance in the *Usage Behaviour of the NICHE PCMS* and contained the following individually significant variable:
    - B1. I buy environmentally friendly products as much as I can (p = 0.036, β = 0.338, B = 0.235).

In the second regression model:

- *Carbon Consciousness* predicted 18.4% of the total variance in the *Usage Behaviour of the NICHE PCMS* and contained the following individually significant variable:
    - B13. I am worried about climate change (p = 0.024, β = 0.274, B = 0.190).

In the third regression model:

- *Intention to Use* predicted 36.9% of the total variance in the *Usage Behaviour of the NICHE PCMS* and contained the following individually significant variable:
    - F23. If it was still available, I would continue to use the NICHE carbon card system to monitor my personal carbon footprint ($p < 0.001$, $\beta = 0.696$, $B = 0.456$).
- *Voluntariness* predicted 13.7% of the total variance in the *Usage Behaviour of the NICHE PCMS* and contained the following individually significant variable:
    - F9. I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island ($p = 0.004$, $\beta = 0.485$, $B = 0.303$).

In the fourth regression model:

- *Perceived Usefulness* predicted 34.7% of the total variance in the *Usage Behaviour of the NICHE PCMS* and contained the following individually significant variables:
    - F14. It has been a valuable use of my time to review the size of my household's carbon footprint ($p = 0.027$, $\beta = 0.299$, $B = 0.212$);
    - F15. Being able to review information about the size of my carbon footprint has saved me money ($p = 0.024$, $\beta = 0.248$, $B = 0.162$); and
    - F16. The information about my household's carbon footprint provided by the NICHE carbon card system was very useful ($p = 0.028$, $\beta = 0.281$, $B = 0.196$).

- *Perceived Ease of Use* predicted 7.3% of the total variance in the *Usage Behaviour of the NICHE PCMS* and contained the following individually significant variable:
    - F13. It was easy to use the NICHE carbon card at the petrol station (p = 0.017, β = 0.271, B = 0.160).

While the *Self-Health Evaluation*, *Subjective Norm*, and *Cost* blocks of variables were not significant, the following variables from these blocks were individually significant in predicting the *Usage Behaviour of the NICHE PCMS*:

- C1. How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health? (p = 0.027, β = 0.269, B = 0.217) from *Self-Health Evaluation*;
- F2. I was encouraged to use the NICHE carbon card system by my household (p = 0.028, β = 0.271, B = 0.146) from *Subjective Norm*; and
- F8. People with a greater carbon footprint should have to pay for it in some way (p = 0.050, β = 0.237, B = 0.140) from *Cost.*

The findings in this section provide future researchers with a solid foundation to predict an individual's usage and acceptability of a PCMS in a broader population sample.

5.5 Chapter Summary

This chapter began with an overview of the data preparation techniques that were employed on the post-PCMS survey. The EFA that was conducted on the post-PCMS dataset was then detailed, and the regression analysis that was run on the post-PCMS dataset was discussed. In the next chapter, the results of the data analysis from the previous chapter and this chapter as it pertains to the three research questions are discussed. The broader NICHE objectives and the additional findings that were identified in the research are then described, and recommendations for future PCT projects are provided.

Chapter 6 - Discussion

6.1 Introduction

This chapter discusses the results of the research and contains the following three sections:

- 6.2 Research Outcomes;
- 6.3 Broader NICHE Objectives and Additional Key Findings; and
- 6.4 Future PCTS/PCMS Projects.

In Section 6.2, the analysis and outcomes from Chapters 4 and 5 are discussed against each of the three research questions. Findings from the research related to the broader objectives of the NICHE project and the additional key findings that were identified during the investigation are described in Section 6.3. The chapter concludes in Section 6.4 with recommendations for future PCTS/PCMS trials. As in previous chapters, in the discussion that follows, the term **significant** refers to a *p*-value that is less than the alpha level of 0.05.

6.2 Research Outcomes

6.2.1 Research Question 1

Research Question 1 – What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?

It is evident that there was a positive shift in attitudes towards the environment, reducing carbon emissions, and climate change following the NICHE PCMS trial as outlined below. When the responses from the pre-PCMS and post-PCMS surveys were compared in Section 4.3, it was shown that post-PCMS survey respondents were significantly more likely to report that they:

- Buy environmentally friendly products as often as possible;
- Worry about climate change;
- Believe in the importance of having a low carbon footprint;
- Believe that collectively households can reduce carbon emissions; and
- Believe most people would accept a PCMS as a tool to improve the environment.

Attitudes towards the environment, reducing carbon emissions, and climate change were also found to be greater predictors of *PCT Attitudes* following the NICHE PCMS trial. This was represented by the increased variance in *PCT Attitudes* explained by the *Carbon Consciousness* and *Consumer Consciousness* blocks of variables that contained measures of these pro-environmental attitudes in the post-

PCMS analysis, and the additional individually significant variables within these blocks (see Section 5.4.1).

It is thought that the positive shift in attitudes towards the environment, reducing carbon emissions, and climate change outlined above, and the subsequent change in the relationship with attitudes towards PCT following the NICHE PCMS trial, was the result of the changing views of NICHE PCMS users. In the post-PCMS survey, the majority of PCMS users reported that:

- The information provided by the NICHE PCMS was very useful (60.7% agreed, 6% disagreed);
- The NICHE PCMS helped them to monitor their environmental impact (58.3% agreed, 10.7% disagreed);
- Reviewing the size of their household's carbon footprint was a valuable use of their time (67.1% agreed, 5.9% disagreed);
- They were more aware of their carbon footprint (76.2% agreed, 4.8% disagreed);
- They were encouraged to reduce their carbon footprint (67.1% agreed, 6.1% disagreed); and
- They would continue to use the NICHE PCMS if it was still available (61.9% agreed, 10.7% disagreed).

It is possible that other factors such as the media or extreme weather events attributed to climate change may have contributed to the shift observed in attitudes towards the environment, reducing carbon emissions, and climate change following the NICHE PCMS trial. Nevertheless, these results suggest that the NICHE PCMS trial and an increased awareness of their household's carbon footprint has altered PCMS users' attitudes towards the environment, carbon emissions, and climate change, thereby changing the relationship between these pro-environmental attitudes and attitudes towards PCT. These changes were observed in practice, with an 18.0% reduction in total household carbon emissions found between comparative April-June quarters of 2013 and 2014 for NICHE PCMS users who were deemed compliant in using their NICHE card when purchasing fuel (Webb, 2018, p. 116).

6.2.2 Research Question 2

Research Question 2 – What differences in attitudes towards PCTS will be evident between those who volunteered for the NICHE PCMS trial and those who did not?

In the comparison of post-PCMS survey items for PCMS users and non-PCMS users in Section 4.5, it was shown that PCMS users were significantly more likely to:

- Support mandatory carbon emission monitoring for individuals and their households;
- Support a cost for carbon emissions;
- Agree that measuring their carbon footprint is important;
- Believe in anthropogenic climate change; and

- Believe most people would accept a PCMS as a tool to improve the environment.

Support for a reward for carbon emissions reduction was the only measure of attitudes towards PCT where no significant difference was found between PCMS users and non-PCMS users.

For PCMS users, much greater levels of variance in *PCTS Attitudes* were predicted by the significant blocks of independent variables that contained measures of attitudes towards the environment, carbon emissions, and climate change (*Consumer Consciousness* and *Carbon Consciousness*). From these blocks of variables, the survey items measuring the importance of having a low carbon footprint, buying environmentally friendly products as often as possible, and worry about climate change were individually significant in predicting the *PCTS Attitudes* of PCMS users. In contrast, for non-PCMS users, much greater levels of variance in *PCTS Attitudes* were predicted by the significant blocks of independent variables that contained measures of the self-reported health of the respondent and attitudes towards body weight (*Self-Health Evaluation* and *Body Weight Consciousness*). From these blocks of variables, the survey items measuring the respondent's confidence in their ability to maintain a healthy body weight, how they viewed their body weight in comparison to others, and the weight loss associated with active transport were individually significant in predicting the *PCTS Attitudes* of non-PCMS users (see Section 5.4.2).

6.2.3 Research Question 3

Research Question 3 – What factors influenced the usage behaviour of the NICHE PCMS?

The significant factors that influenced the *Usage Behaviour of the NICHE PCMS* were *Carbon Consciousness, Consumer Consciousness*, *Voluntariness, Perceived Usefulness, Perceived Ease of Use*, and *Intention to Use*. While *Self-Health Evaluation, Subjective Norm*, and *Cost* were not found to be significant, within these blocks of variables, the survey items measuring the amount of physical activity undertaken to maintain health, encouragement by other household members, and support for a cost for carbon emissions were individually significant in predicting the *Usage Behaviour of the NICHE PCMS* (see Section 5.4.3).

In the previous section, for PCMS users, it was reported that much greater levels of variance in *PCTS Attitudes* were predicted by the significant *Consumer Consciousness* and *Carbon Consciousness* blocks of variables. The results summarised in this section show that these blocks of variables were also significant predictors of the *Usage Behaviour of the NICHE PCMS*, and confirm that there are similarities in the factors that explain PCT attitudes and PCMS usage behaviour for those who would voluntarily use a PCMS. This is an important finding as it gives future researchers a starting point to predict voluntary PCMS usage based upon an individuals' attitudes towards PCT.

All of the other factors that predicted the *Usage Behaviour of the NICHE PCMS* were identified in the review of the TAM2 literature. Based on the results discussed in the previous paragraph, it appears that attitudes towards PCT may predict voluntary PCMS usage initially. Nevertheless, given that TAM2 determines how users come to use and accept technology, it seems that continued usage, acceptance, and adoption of a PCMS is reliant on the individual finding the system easy to use (*Perceived Ease of Use*), and in particular, useful (*Perceived Usefulness*). This is highlighted by the fact that *Perceived Usefulness* explained the second-highest level of variance, and all three of the survey items that made up the *Perceived Usefulness* block of variables were individually significant in predicting the *Usage Behaviour of the NICHE PCMS*. While not tested in the research, it is also highly likely that the *Usage Behaviour of the NICHE PCMS* influenced *Perceived Usefulness*, i.e. the more an individual used the NICHE PCMS, the more useful they thought it was. The only block of variables that explained higher levels of variance than *Perceived Usefulness* was *Intention to Use*, which, in the context of this research, measured whether the user would continue to use the NICHE PCMS if it was still available. While it was not tested for in this research, it is thought that *Perceived Usefulness* contributed to the high level of variance explained by *Intention to Use*. Technology acceptance and the NICHE PCMS is discussed further in Section 6.3.5.

6.3 Broader NICHE Objectives and Additional Key Findings

6.3.1 Health and the NICHE PCMS

An objective of the NICHE project was to examine the link between health and PCTS. The review of the literature was unable to identify any research outside of the NICHE project that sought to use empirical evidence to explore the direct relationship between health and attitudes towards PCT, or health and voluntary PCMS usage. The post-PCMS analysis confirmed the findings of the pre-PCMS analysis and identified that there was a relationship between health and attitudes towards PCT following the NICHE PCMS trial (see Section 5.4.1). However, on further examination, the health-related blocks of variables (*Self-Health Evaluation* and *Body Weight Consciousness*) were found to be much greater predictors of the *PCTS Attitudes* for non-PCMS users, who did not voluntarily take part in the NICHE PCMS trial (see Section 5.4.2 and 5.4.3). While this is an important finding, it must be noted that it may be in part owing to the increased discussion surrounding the links between health, body weight, and carbon emission, and the health studies resulting from the NICHE PCMS trial. None of the health-related blocks of variables were found to be significant in predicting the *Usage Behaviour of the NICHE PCMS* (see Section 5.4.3). Given the relationship between health and *PCTS Attitudes* for non-PCMS users, it is probable that there is a relationship between health and voluntary PCMS usage for those who would not voluntarily use a PCMS, although this was not tested in the current research. Nevertheless, with the exception of the individually significant variable that measured the amount of physical activity undertaken to maintain health, the research did not show any association between health and PCMS usage for those who would voluntarily use a PCMS.

In other research emanating from the NICHE project, no significant changes were found in the actual body weight for participants who underwent anthropometric and movement studies before and after the NICHE PCMS trial (Webb, 2018, p. 116). While an increase in the variance explained by *Body Weight Consciousness* was found in the comparison of the pre-PCMS and post-PCMS regression models in Section 5.4.1, the *Self-Health Evaluation* block of variables was no longer significant. Therefore, it appears the NICHE PCMS trial did not have an impact on attitudes towards health and body weight for post-PCMS survey respondents, or the actual health and body weight of those who participated in the trial.

6.3.2 The Environment and the NICHE PCMS

One of the aims of the NICHE project was to examine the link between the environment and PCT. Attitudes towards the environment, reducing carbon emissions, and climate change were found to be significant predictors of *PCTS Attitudes* and the *Usage Behaviour of the NICHE PCMS* for PCMS users (see Sections 5.4.2 and 5.4.3). Given that a PCMS is a tool designed to limit the human contribution to climate change through the mitigation of carbon emissions with the goal of bringing about environmental change, these results were expected.

However, when the responses to a sample of survey items that measured attitudes towards the environment, carbon emissions, and climate change were compared for PCMS users and non-PCMS users, no significant difference was found between the groups (see Section 4.5.3). This was a surprise as NICHE researchers had expected PCMS users to register higher levels of agreement for these survey items. The findings for some of these survey items are also at odds with the PCT simulation research conducted by Capstick and Lewis (2010, p. 380) that identified:

- A significant inverse correlation between carbon footprint size and support for PCT, indicating that those with smaller carbon footprints are more likely to support PCT; and
- A significant positive correlation between the level of climate change concern and support for PCT.

In contrast, Mann-Whitney U tests found no significant difference between the responses to the following survey items for PCMS users and non-PCMS users, and correlation analysis found that the relationships between the following survey items and voluntary usage of the NICHE PCMS were not significant:

- A7. Compared to others on Norfolk Island, do you think your carbon footprint is/would be? (Mann Whitney U test $p = 0.618$, correlation analysis $p = 0.739$);
- B5. It is important for me to have a low carbon footprint (Mann Whitney U test $p = 0.398$, correlation analysis $p = 0.271$); and
- B13. I am worried about climate change (Mann Whitney U test $p = 0.481$, correlation analysis $p = 0.373$).

It is important to note that only 1.2% of PCMS users and 1.4% of non-PCMS users believe that climate change is not happening at all. The remainder of PCMS users and non-PCMS users believe climate change is happening. While PCMS users were significantly more likely to believe in anthropogenic climate change than non-PCMS users, the difference between the groups was about the *cause* of climate change, not its existence, with some contending that climate change is a natural fluctuation in the earth's temperature (see Section 4.5.1). These results differ from previous studies examining climate change scepticism that found a sizable percentage of respondents deny the existence of climate change altogether (see Section 2.3.2.2). It is possible that, while some post-PCMS survey respondents disagree that human activity is the cause of climate change, they are worried about climate change nonetheless. This could explain why no significant relationship or difference was found between the level of climate change concern and voluntary usage of the NICHE PCMS.

The self-reported carbon footprint of some post-PCMS survey respondents may have been affected by the higher proportion of households on Norfolk Island having solar power and solar hot water, the higher costs of power and fossil fuels, and lower average wages when compared to the Australian mainland. The geographic isolation and small size of Norfolk Island could also be expected to make the residents more conscious of their resource use, thus affecting the self-reported carbon footprint of some post-PCMS survey respondents. These factors were discussed as limitations of the current research in Section 1.7 of the introductory chapter and could reasonably be expected to foster a general interest in sustainability and careful resource use for some residents of Norfolk Island. Owing to this, it is conceivable that some survey respondents may report having a low self-assessed carbon footprint as they actively minimise their energy usage for financial or sustainability reasons as opposed to environmental reasons. For the same reasons, the importance of having a low carbon footprint may be seen by some survey respondents as associated with energy savings for financial reasons or careful resource use rather than mitigating anthropogenic climate change. This could explain why no significant relationship or difference was found between self-assessed carbon footprint size and voluntary usage of the NICHE PCMS or the importance of having a low carbon footprint and voluntary usage of the NICHE PCMS.

It is also possible that the difference in findings reported here may be partly attributable to the lack of trading or the design of the NICHE PCMS. The research by Capstick and Lewis (2010) used a PCT simulation and was assessing support for mandatory PCT. As there would be a financial benefit for those with smaller carbon footprints, this may explain why these individuals were more likely to support PCT. Whereas the current study assessed voluntary PCMS usage, and there were no financial incentives or penalties for carbon footprint size. Further, owing to the short length of the NICHE PCMS trial, the carbon reduction target was introduced after only six months and was greater than would be the case in the early years of any of the proposed PCT schemes. Based on these results, it is clear that further research is required to see if the findings of the current research are unique to Norfolk Island or indicative of wider attitudes and behaviours.

In the pre-PCMS regression analysis, the *Environmental Action* block of variables that contained measures of an individuals' environmental behaviours was only significant in predicting the *Usage Intentions towards a PCTS* for those who believed that they had a lower than average carbon footprint (Hendry, 2014, p. 169). In the post-PCMS regression analysis, *Environmental Action* was not a significant predictor of the *PCTS Attitudes* for PCMS users and non-PCMS users (see Section 5.4.2), or of the *Usage Behaviour of the NICHE PCMS* (see Section 5.4.3). It had been expected that a person who displays positive environmental behaviours would be motivated to use a system like the NICHE PCMS to bring about environmental change.

However, it is important to note that the *Environmental Action* block of variables contained survey items measuring environmental behaviours that are *not* related to carbon emissions or climate change. It was shown in Section 2.3.2.2 that political values are among the strongest determinants of climate change scepticism and other factors including the media, issue fatigue, distrust, the deepening politicisation of the issue, and the economy contribute to anthropogenic climate change beliefs. Therefore, an individual may display environmentally friendly behaviours while also being sceptical of anthropogenic climate change and having a negative opinion of PCTS and PCMS. Conversely, an individual may display environmentally friendly behaviours while believing in anthropogenic climate change and having a favourable view of PCT and PCMS. Research conducted by Defra (2008c) to segment the United Kingdom population by environmental attitudes and behaviours identified a group titled 'waste watchers' who are doing more than any other group to help the environment. Nevertheless, their behaviour is driven by the desire to avoid waste rather than environmental reasons. Nearly three-quarters of this group are satisfied with their contribution to helping the environment, and they are more likely to be sceptical about the urgency and scale of environmental problems. As a result, these individuals may display environmentally friendly behaviours that are not directly related to the environment or attitudes towards PCT and PCMS. The financial and sustainability motives listed in the previous paragraph could also result in pro-environmental behaviours that have little to do with actual concerns for climate change.

Any of the reasons outlined above may account for the non-significance of *Environmental Action* in predicting the *PCTS Attitudes* of PCMS users and non-PCMS users, or the *Usage Behaviour of the NICHE PCMS*. These findings warrant further research to determine if the non-significance of *Environmental Action* is a limitation of the study owing to the unique nature of Norfolk Island, or whether other attitudes negate the influence of environmental behaviours in predicting attitudes towards PCT and voluntary usage of a PCMS.

6.3.3 Public acceptability of PCTS

An aim of the broader NICHE project was to investigate the public acceptability of PCT. The NICHE PCMS was not technically a PCTS as it did not facilitate any trading of carbon allowances. Nevertheless, it was based upon the most well-developed conceptual downstream PCT schemes that were identified in the review of the PCT literature and contained the carbon emissions capture, reporting, and reduction target components that form the basis of a PCT. Therefore, the public acceptability of PCT systems discussed in this section describes attitudes relating to the NICHE PCMS and PCT in general. All of the proposed PCT schemes are mandatory in nature and periodically allocate carbon allowances that are tradable to meet the requirements of above-average and below-average carbon emitters, resulting in a carbon price (Roberts & Thumim, 2006, p. 4; Parag & Eyre, 2010, p. 354; Fawcett & Parag, 2010a, p. 332; Fawcett, 2012, p. 283).

The post-PCMS survey contained the following questions to measure the public acceptability of mandatory usage and carbon pricing:

- F6. It should be compulsory for people to monitor the size of their carbon footprint;
- F7. People who reduce their carbon footprint should be rewarded in some way;
- F8. People with a greater carbon footprint should have to pay for it in some way; and
- F9. I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island.

Table 6-1 below shows the breakdown for the responses for *all* post-PCMS survey respondents to the above survey items.

	F6	F7	F8	F9
ALL Respondents				
1 – strongly agree	9.5%	13.7%	12.0%	12.7%
2	11.3%	14.9%	12.6%	13.9%
3	15.5%	23.8%	16.2%	19.3%
4 – neutral	33.3%	30.4%	29.3%	31.9%
5	6.5%	6.0%	9.6%	4.8%
6	8.9%	3.0%	9.0%	7.8%
7 – strongly disagree	14.9%	8.3%	11.4%	9.6%
Agree (1–3)	36.3%	52.4%	40.7%	45.8%
Neutral (4)	33.3%	30.4%	29.3%	31.9%
Disagree (5–7)	30.4%	17.3%	29.9%	22.3%

Table 6-1 Mandatory Use and a Carbon Price for All Post-PCMS Survey Respondents

Table 6-1 above illustrates that for *all* post-PCMS survey respondents:

- 40.7% agree with a cost for greater carbon emissions compared with 29.9% who disagree (Survey Item F8);
- 52.4% support a reward for reducing carbon emissions compared with 17.3% who disagree (Survey Item F7);
- 36.3% support the introduction of compulsory carbon emission monitoring compared with 30.4% who disagree (Survey Item F6); and
- 45.8% support the introduction of a mandatory NICHE PCMS compared with 22.3% who disagree (Survey Item F9).

It is not clear why there was additional support for the introduction of a mandatory NICHE PCMS as opposed to the compulsory introduction of carbon footprint monitoring. It is conceivable that familiarity with the NICHE PCMS, as opposed to an unknown carbon monitoring system, could explain the differences found between these survey items. If this is the case, additional educational efforts aimed at increasing the familiarity of PCT and highlighting the benefits may have similar results. It must be noted that it was not compulsory for NICHE participants to use their carbon cards when purchasing fuel, and the NICHE PCMS did not require any additional user interaction. How compulsory carbon emission monitoring would work, what it would cover, and whether it would be burdensome or intrusive for indiviuals in unknown. This may also explain why there was additional support for the introduction of a mandatory NICHE PCMS as opposed to compulsory carbon emission monitoring.

Based on these responses, a reward for reducing carbon emissions was the only survey item found to be supported by the majority of survey respondents. Nevertheless, given the high rate of neutral responses, the majority of survey respondents do not oppose the central tenets of PCT. These results are at odds with the study of Bristow et al. (2010, p. 1833), where it was found that the acceptability of PCT could reach 80%. However, the percentage of post-PCMS survey respondents who agreed with the four survey items was higher than those who disagreed. In comparison, research by Bird et al. (2009) found that only 31% of survey respondents tend to support or strongly support PCT, compared with 40% who tend to oppose or strongly oppose PCT. A public acceptability study conducted by Owen et al. (2008) for the PCT pre-feasibility study that was undertaken by the United Kingdom Department for Environment, Food and Rural Affairs (Defra) found that 2% of respondents were very positive and 24% were quite positive about PCAs compared with 41% who were very negative and 13% who were quite negative. In both studies, opposition against PCT was stronger than support for PCT. Therefore, it seems that the NICHE PCMS, and PCT in general, had higher levels of public acceptability following the NICHE PCMS trial than was found in the research by Owen et al. and Bird et al.

It was not possible to compare the differences between the pre-PCMS and post-PCMS surveys for the survey items on mandatory use as they were only included in the post-PCMS survey. No significant difference between the pre-PCMS and post-PCMS surveys was found for a reward for reducing carbon emissions, and there was a significant decrease in the percentage of post-PCMS survey respondents who agreed with a cost for greater carbon emission (see Section 4.3.2). However, as Table 6-1 shows, the percentage of respondents who were neutral for the four survey items was reasonably consistent, ranging from 29.3% to 33.3%. Therefore, it is clear that a sizable proportion of post-PCMS survey respondents do not have a strong opinion for or against mandatory use and a carbon price following the NICHE PCMS trial. Based on this, further research is needed to identify additional strategies to improve the acceptability of PCT, particularly among those individuals who neither support or oppose mandatory usage or carbon pricing.

Table 6-2 below shows the breakdown for the responses to the survey items measuring support for mandatory usage and carbon pricing for PMCS users and non-PCMS users.

	F6	F7	F8	F9
PCMS Users				
Agree (1–3)	47.7%	51.1%	46.0%	60.5%
Neutral (4)	34.1%	38.6%	32.2%	26.7%
Disagree (5–7)	18.2%	10.2%	21.8%	12.8%
Non-PCMS Users				
Agree (1–3)	22.2%	56.3%	32.4%	26.8%
Neutral (4)	34.7%	22.5%	29.6%	38.0%
Disagree (5–7)	43.1%	21.1%	38.0%	35.2%
Mann-Whitney U Tests				
Mann-Whitney U	3890.5	2602.0	3429.5	3820.5
Significance	0.001	0.242	0.039	< 0.001

Table 6-2 Mandatory Use and a Carbon Price for PCMS Users and Non-PCMS Users

Table 6-2 above shows that, among PCMS users, support for carbon emissions monitoring was stronger than opposition, whether it is the NICHE PCMS (Survey Item F9) or some other kind of compulsory carbon emission monitoring program (Survey Item F6). However, even though PCMS users voluntarily used the NICHE PCMS, only 60.5% agreed that use of the NICHE PCMS should be mandatory, and only 47.7% agreed that it should be compulsory for people to monitor the size of their carbon footprint. For non-PCMS users, opposition against both options was much stronger than support.

While more PCMS users agreed with a cost for greater carbon emissions (Survey Item F8) than disagreed, only 46% of PCMS users registered their support. For non-PCMS users, a higher percentage disagreed with a cost for greater carbon emissions, than agreed. The level of support for a reward for reducing carbon emissions (Survey Item F7) was higher among both groups, with 51.2% of PCMS users and 56.3% of non-

PCMS users in agreement. This was the only survey item discussed in this section where support among non-PCMS users was stronger than opposition, and a higher percentage of non-PCMS users registered agreement than PCMS users. The level of support among non-PCMS users for a reward for reducing carbon emissions was surprising given that 41.1% of non-PCMS users reported that they believe climate change is a natural fluctuation in the earth's temperature and is not caused by human activity. Therefore, it appears that some non-PCMS users agreed with a reward for reducing carbon emissions, while also holding sceptical anthropogenic climate change views.

It is possible that the design of the NICHE PCMS may have lessened support a cost for greater carbon emissions (Survey Item F8) than would otherwise be the case. Owing to the duration of the NICHE PCMS trial, a large reduction target was introduced over a short period of time, as opposed to phasing it in in smaller increments over a longer time period. This may have led to an over-exaggerated sense of how quickly and how much households with carbon emissions above the reduction target would need to reduce their emissions in order to avoid paying for extra carbon allowances under a PCT scheme. This is discussed further as a limitation of the study in Section 7.4. Nevertheless, the results discussed in this section demonstrate that there would be a problem politically for any government agency contemplating the introduction of a mandatory PCT scheme designed that includes a cost for carbon emissions. Given that PCMS users voluntarily used a PCT-like system, any PCT scheme that was implemented would need to gain the support of and be acceptable to individuals who would not voluntarily use it. Non-PCMS users were approximately

2.5 times more likely to agree with a reward for carbon emission reductions than disagree, and a reward for carbon emission reductions was supported by the majority of PCMS users and non-PCMS users. Based on these results, it is not socially and politically acceptable to implement a system that includes a cost for greater carbon emissions. As a result, additional efforts are required to educate households on the need for schemes that place a cost on carbon emissions.

6.3.4 Voluntary Usage and Climate Change beliefs

6.3.4.1 Anthropogenic Climate Change Believers

In the post-PCMS survey, 57.5% of non-PCMS users reported that they believe climate change is caused by human activity, yet they did not voluntarily take part in the NICHE PCMS trial. In Table 6-3 below, the levels of agreement for three survey items for PCMS users and non-PCMS users who *believe climate change is caused by human activity* are compared.

Survey Item	PCMS users	Non-PCMS users
B5. It is important for me to have a low carbon footprint	93.8%	83.3%
F1. Being able to measure my carbon footprint is important to me	81.3%	47.5%
F5. Most people would accept the NICHE carbon card system as a tool for improving the environment	73.4%	45.9%

Table 6-3 Anthropogenic Climate Change Believers – PCMS users vs. Non-PCMS Users

It can be seen that there were similar levels of agreement for the importance of having a low carbon footprint for PCMS users and non-PCMS users who believe in anthropogenic climate change, and a Mann-Whitney U test found no significant (p = 0.323) difference between them. However, PCMS users were significantly more likely to agree that being able to measure their carbon footprint is important. PCMS users were also significantly more likely to believe most people would accept the NICHE PCMS as a tool for improving the environment.

For those non-PCMS users who believe in anthropogenic climate change and *do* agree that being able to measure their carbon footprint is important and *do* accept the NICHE PCMS as a tool for improving the environment, lack of voluntary participation may be explained by the value-action gap. However, research by Kogut, Beyth-Marom, and Making (2008) has shown that individuals generally believe that they are more willing than most to address a collective problem and underestimate the willingness of others to perform the same actions. This can lead them to make decisions that are incompatible with their best interests owing to the belief that others will not cooperate to a sufficient degree to make a significant impact on the problem. This may explain the non-participation of some of these non-PCMS users. It is also possible that the lack of a financial incentive for emissions reductions in the NICHE PCMS trial removed the incentive for these individuals to participate.

For those non-PCMS users who believe in anthropogenic climate change yet *do not* agree that being able to measure their carbon footprint is important and *do not* accept the NICHE PCMS as a tool for improving the environment, it could be that lack of ascribed personal responsibility is to blame. Round Eight of the European Social Survey found that, despite most people accepting that climate change is a problem, many only feel a moderate responsibility to personally do something about it, believing that personal attempts to reduce energy will not be effective (Poortinga et al., 2018, p. 15). In the United Kingdom, only 25% of people thought that the general public should have the most responsibility for tackling climate change by making changes to their lifestyle (Department for Business, Energy & Industrial Strategy, 2020, p. 23). The results discussed in this section highlight the need for further research examining why individuals who believe in anthropogenic climate change would not voluntarily participate in a PCMS trial and identify potential strategies to improve the acceptability of PCMS among them.

6.3.4.2 Climate Change Scepticism and Subjective Norm

Subjective Norm was not found to be a significant predictor of the *Usage Behaviour of the NICHE PCMS*, and the post-PCMS Survey Item F4 (*There was pressure from the community to use the NICHE carbon card system*) was not found to be individually significant. However, the Survey Item F2 (*I was encouraged to use the NICHE carbon card system by my household*) from the *Subjective Norm* block of variables was individually significant in predicting the *Usage Behaviour of the NICHE PCMS*.

While the majority of PCMS users believe climate change is caused by human behaviour, 23.5% of PCMS users reported that they believe climate change is a natural fluctuation in the earth's temperature. For these PCMS users, there would be little motivation to use the NICHE PCMS for the sole purpose of monitoring their carbon emissions. Of these PCMS users who hold sceptical anthropogenic climate change beliefs, 70.0% agreed they were encouraged to register for the NICHE PCMS trial by their household. In comparison, only 20.8% of non-PCMS users who hold sceptical anthropogenic climate change beliefs agreed that they were encouraged to use the NICHE PCMS by their household.

There are other reasons why PCMS users who hold sceptical anthropogenic climate change beliefs may have registered for the NICHE PCMS trial, such as the incentives offered on petrol and diesel purchases. However, it seems that within some households, there are differing opinions on the causes of climate change and the value of a PCMS, and encouragement from family members could have been a contributing factor in voluntary usage of the NICHE PCMS, particularly among climate change sceptics. The results found in this section warrant further research into the differing climate change beliefs within households, and other factors that may influence voluntary PCMS usage, and by extension, voluntary PCT usage by individuals who do not believe that climate change is the result of human activity.

While Survey Item F4 (*There was pressure from the community to use the NICHE carbon card system*) was not found to play a role in voluntary usage of the NICHE PCMS, further research into the role of social norms in the community and voluntary usage of a PCMS is warranted. While subjective norms are determined by the perceived social pressure from others to perform a certain action, descriptive norms are determined by the perception of which behaviours are typically performed, and injunctive norms are determined by the perception of which behaviours are typically approved or disapproved (Schultz et al., 2007). The role that descriptive norms and injunctive norms played in voluntary participation in the NICHE trial was not tested in the research. Nevertheless, it is probable that some individuals may have volunteered to participate in the NICHE PCMS trial owing to a belief that their friends or people who are important to them were also going to participate. This descriptive norm may have given rise to the injunctive norm that participating in the NICHE PCMS trial was the approved behaviour in their community. Conversely, others may not have participated in the NICHE PCMS trial because of the belief that others were not going to participate, thereby resulting in the injunctive norm that participating in the NICHE PCMS trial was the not approved behaviour in their community. The literature also shows that many people are unaware of how much they are influenced by social norms. This was demonstrated by Nolan et al. (2008, p. 913) in an energy conservation study that found that “normative social influence produced the greatest change in behaviour compared to information highlighting other reasons to conserve, even though respondents rated the normative information as least motivating”.

6.3.5 Technology Acceptance and PCMS

After reviewing the available literature, it was determined that the research presented herein represents the first study of its kind to adapt a technology acceptance model to examine usage of a PCMS. As discussed in Section 6.2.3, when the factors that influenced the *Usage Behaviour of the NICHE PCMS* were summarised, all but one of the factors identified in the review of the TAM2 literature were significant. The one factor that was not significant was *Subjective Norm*, and as discussed in the previous section, further research is required as other social norms may need to be considered when examining voluntary PCMS usage. These results indicate the usefulness and validity of technology acceptance for household acceptance studies and should be considered by any researcher investigating the potential acceptance of a PCMS or PCTS in a larger population sample. The gender and age moderators from the UTAUT technology acceptance model should also be considered, since the review of the literature identified that gender and age often influence concern about, and willingness to act on climate change (see Section 2.3.2.2). This was not possible in the current research owing to the sample size of PCMS users (see Section 7.4).

6.4 Future PCTS/PCMS Projects

Section 3.2.2 detailed the lack of support provided by the banking sector for the use of their infrastructure to trial a PCTS and establish a carbon bank on Norfolk Island. Without access to the EFTPOS (electronic funds transfer point of sale) banking infrastructure to record transactions, all of the petrol stations had to be fitted with custom POS terminals to capture sales data, and financial incentives had to be offered for their participation. In a larger-scale PCTS/PCMS trial, even with incentives being offered, it is likely that some petrol stations may decline to be involved. The custom POS added an additional step in processing customer payments as customers had to scan their NICHE carbon card to register their purchases. While 85.2% of PCMS users agreed that the NICHE PCMS was easy to use, 6.8% of PCMS users disagreed (see Section 4.6), and this disagreement is likely as a result of the additional step required. To identify any participants not thought to be compliant in registering their purchases, algorithms had to be incorporated into the system so that their carbon emissions data could be flagged.

A second challenge was that the utility companies had to provide their data in a specific format so that it could be entered into the NICHE database via a custom web service. As there were only two utility companies on Norfolk Island, both of which were operated by the local government, and the local government supported the NICHE PCMS trial, there was no difficulty in arranging their involvement. In a larger-scale PCTS/PCMS trial in a different location, for example, in mainland Australia, where there are dozens of utility companies that are private entities, it is unlikely that this would be a satisfactory solution. Given these difficulties, it is clear that a stand-alone system like the NICHE PCMS would not be suitable for a larger PCTS/PCMS trial in a different location.

Ideally, any future PCTS or PCMS trial would be entirely seamless for the end-user and would be without the extra step required to register purchases. However, to create such a system, integration with all existing infrastructure to automatically track power and fossil-fuel purchases would be necessary. This would rely on the cooperation of many large corporations across a range of industries. As many of these companies would stand to be less profitable under a PCTS/PCMS trial if there was a reduction in their sales as a result of users attempting to minimise their carbon emissions, it is difficult to imagine all of them agreeing to take part unless it was supported or mandated by a government body or regulatory authority.

A second option would be to create a system similar to a frequent flier or shopping loyalty program if access could be gained to the EFTPOS banking infrastructure. While this would still require an extra step for users to scan a card, much like the current NICHE PCMS, it would be suitable for a larger PCTS/PCMS trial in a different location. However, further research would be required to assess what purchases could be tracked in this way, and it is possible some items like utility bills may need to be manually entered by the user into the system. This would need to be considered as the TAM2 and TAM3 literature shows that that *Perceived Ease of Use* has a positive effect on *Perceived Usefulness* (Venkatesh & Davis, 2000, p. 192). In the current research, *Perceived Usefulness* predicted 34.7% of the total variance in the *Usage Behaviour of the NICHE PCMS,* while all three of the survey items that were included in the post-PCMS survey as measures of *Perceived Usefulness* were individually significant. Any system not perceived as being useful would be unlikely to be accepted and adopted by the users. Prior to any future PCTS/PCMS project being implemented on a larger scale requiring some form of additional user involvement to obtain their exact carbon footprint, further research would be necessary to identify what level of user involvement would be acceptable to the majority of users.

Another area that would require further research for a future PCTS/PCMS trial on a larger scale would be the calculation of carbon emissions associated with products and services. For example, additional carbon emissions are involved in the transportation of fossil fuels to their point of sale, and this would vary between locations. The carbon footprint of electricity would also depend on what fossil fuel source was used for power generation and how efficient it was, so if multiple utility companies were covered by the trial, this would need to be considered. This was not a problem in the current research as there was only one power provider on Norfolk Island, and all fuel sold at the petrol stations used the same transportation method.

Finally, the NICHE PCMS did not include financial penalties for above-allowance emitters, or incentives for below-allowance emitters, and owing to the short duration of the trial a large carbon reduction target was implemented after only six months of baseline data collection. This is discussed further in Section 7.4 as a limitation of the study. Ideally, any future PCTS/PCMS trial would include some sort of financial incentive or penalty for above and below-allowance emitters and would operate for a longer period of time. This would allow the collection of baseline averages for more than six months, and the introduction of a reduction target in phased small increments to allow users to gradually reduce their emissions over time.

6.5 Chapter Summary

This chapter discussed the results of the data analysis that was described in Chapters 4 and 5 as it relates to the three research questions and the broader NICHE objectives. Additional key findings that were identified during the data analysis were then described, and recommendations for future PCT/PCMS trials were provided. In the next chapter, the results of the research are summarised. The significance of the research, the limitations of the research that were uncovered during the investigation, and recommendations for future research are described.

Chapter 7 - Conclusion

7.1 Introduction

This chapter summarises the research and contains the following sections:

- 7.2 Summary of the Research;
- 7.3 Significance of the Research;
- 7.4 Limitations of the Research;
- 7.5 Future Research; and
- 7.6 Chapter Summary.

The findings of the research are reviewed in Section 7.2. In Sections 7.3 and 7.4, the significance of the research and the limitations of the research that were identified during the investigation are discussed. Recommendations for future research based on the findings of the investigation are provided in Section 7.5, followed by concluding remarks in Section 7.6.

7.2 Summary of the Research

The research reported in this thesis aimed to identify:

1. What changes in attitudes towards PCTS will be evident following the NICHE PCMS trial?

2. What differences in attitudes towards PCTS will be evident between those who volunteered for the NICHE PCMS trial and those who did not?
3. What factors influenced the usage behaviour of the NICHE PCMS?

The research has shown that there was a significant shift in attitudes and behaviours towards the environment, reducing carbon emissions, and climate change following the NICHE PCMS trial and these attitudes and behaviours were found to be greater predictors of attitudes toward PCTS. These changes were thought to be as a result of the NICHE PCMS trial and the changing views of PCMS users towards their carbon emissions, carbon footprint, and environmental impact. PCMS users were significantly more likely to believe in anthropogenic climate change and display positive attitudes towards PCT than non-PCMS users. For PCMS users, their attitudes towards PCT were predicted by their attitudes towards the environment, carbon emissions and climate change. Whereas, for non-PCMS users, their attitudes towards PCT were predicted by their self-reported health and their attitudes towards body weight. The significant factors that were found to influence the *Usage Behaviour of the NICHE PCMS* were *Carbon Consciousness*, *Consumer Consciousness*, *Voluntariness*, *Perceived Usefulness*, *Perceived Ease of Use,* and *Intention to Use*. Similarities were found between attitudes towards PCT and voluntary usage of a PCMS for PCMS users, and technology acceptance was identified as being highly relevant when assessing the usage and acceptance of a voluntary PCMS.

The broader objectives of the NICHE project were to trial a voluntary PCTS and investigate its public acceptability, together with its effect on health, carbon emissions, and the environment. While the central tenets of PCT (mandatory use and a carbon price) were found to be more acceptable among PMCS users than non-PCMS users, support for a reward for reducing carbon emissions was the only measure of PCT acceptability that was supported by the majority of post-PCMS survey respondents. However, approximately 30% of post-PCMS survey respondents did not have a strong opinion for or against mandatory use and a carbon price following the NICHE PCMS trial. Health was found to be a much greater predictor of attitudes towards PCT for non-PCMS users than PCMS users. The amount of physical activity undertaken to maintain health was the only any association found between health and the usage of the NICHE PCMS for PCMS users. Based on the comparison of the pre-PCMS and post-PCMS analysis, it appears that the NICHE PCMS trial did not have an impact on attitudes towards health and body weight and their relationship with attitudes towards PCT. In contrast, as outlined at the start of this section, significant changes in attitudes and behaviours towards the environment, carbon emissions and climate change, and their relationship with attitudes towards PCT, were found following the NICHE PCMS trial.

When a comparison between PCMS users and non-PCMS users *who believe in anthropogenic climate change* was undertaken, the research found no significant difference in the importance of having a low carbon footprint. However, PCMS users were significantly more likely to agree that being able to measure their carbon footprint is important, and accept the NICHE PCMS as a tool for improving the environment. The comparison of PCMS users and non-PCMS users *who do not believe in anthropogenic climate change* found that the PCMS users were significantly more likely to have been encouraged by other members of their household to participate in the NICHE PCMS trial.

7.3 Significance of the Research

At the start of the investigation, the PCT research was theoretical in nature, and the behavioural changes associated with the introduction of PCT, and the public acceptability of PCT, had been examined using hypothetical examples and simulations. The NICHE PCMS trial was the first voluntary trial of its kind that tested several significant aspects of a PCTS, in a real-world environment. This allowed the examination of the following areas that have not been possible in previous studies:

- A comparison of ex-ante and ex-post attitudes and behaviours;
- The differences in attitudes and behaviours between those who would voluntarily use a PCMS and those who would not; and
- The factors that determine the voluntary usage and acceptance of a PCMS.

As a result, the current research is the first of its kind that has:

- Identified that use of a PCMS would encourage users to reduce their carbon footprint and environmental impact, resulting in a positive change in attitudes towards the environment, carbon emissions, and climate change;
- Determined that attitudes towards the environment, reducing carbon emissions, and climate change are the predictors of PCT attitudes for those who would voluntarily use a PCMS;

- Determined that attitudes towards health and body weight are the predictors of PCT attitudes for those who would not voluntarily use a PCMS;
- Explored climate change scepticism and voluntary PCMS usage;
- Examined the public acceptability of PCT for those who would voluntarily use a PCMS and those who would not;
- Identified the similarities between PCT attitudes and voluntary usage of a PCMS;
- Identified the factors that predict voluntary PCMS usage; and
- Adapted a technology acceptance model to examine usage of a PCMS and identified its validity for household acceptance studies.

The findings of the research have provided valuable evidence of the benefits of carbon emissions monitoring and the need for further studies of a similar kind, on a larger scale. While not a true PCTS, the NICHE PCMS trial represented several significant aspects of a PCTS. The 18.0% reduction in total household carbon emissions found following the NICHE PCMS trial (Webb, 2018, p. 116) demonstrate that the non-financial aspects of PCT can have a significant impact on emissions, beyond that of a carbon price, which has not been demonstrated before. As a result, the research conducted for this thesis has made a valuable contribution to the PCT literature that will provide future researchers with a better understanding of the role that a PCMS can play in efforts to combat carbon emissions and how best to examine PCMS usage, acceptance, and adoption in any future trials.

7.4 Limitations of the Research

The limitations of the research that were identified at the beginning of the project were discussed in Section 1.7 of the introductory chapter. Additional limitations that were uncovered during the investigation are discussed in this section.

Norfolk Island experienced an economic downturn and a collapse of the local government during the NICHE PCMS trial. In March 2015, the self-governance of Norfolk Island was revoked and was replaced by a local council incorporated into the state of New South Wales on the Australian mainland. The government changes were contrary to the wishes of many of the residents, with 68% of voters being against the forced changes (Radio New Zealand, 2015). This process sharply divided the community and resulted in a petition to the United Nations for Norfolk Island's listing as a non-self-governing territory (ABC, 2019), and a movement to become a part of New Zealand (The Guardian, 2017). As the local government was a sponsor of the NICHE study, and the research was conducted from mainland Australia and funded by the Australian Government, these local attitudes indirectly created some tension towards the NICHE project. In addition, there were multiple surveys run on the Island in the lead up to and at the same time as the post-PCMS survey was conducted that were related to political issues and the changes in government. This may have resulted in survey fatigue and could have affected the sample size of the post-PCMS survey, while the downturn in numbers may have influenced the survey results. It also dictated the data analysis techniques that were available for the post-PCMS analysis.

A further limitation was the anonymous nature of the pre-PCMS and post-PCMS surveys. Owing to the personal information collected in the surveys, the NICHE study committee, the focus groups established at the start of the project, and the focus group that examined the pre-PCMS survey felt that most residents would not participate in the survey if identifying information was required. As a result, the pre-PCMS and post-PCMS surveys were confidential and contained no data that could be used to identify the respondent. While this maximised participation rates, it did not allow for the identification of the pre-PCMS respondents who ultimately participated in the NICHE PCMS trial and also limited the analysis that could be undertaken to identify the changes in attitudes across the NICHE PCMS trial for PCMS users and non-PCMS users. It also did not allow for any additional surveys to confirm some of the findings of the research.

The comparison of PCMS users and non-PCMS users in Section 4.4 found that:

- A higher proportion of women than men signed up their household to participate in the NICHE PCMS trial when compared to the gender distribution of Norfolk Island;
- Women made up a higher proportion of post-PCMS survey respondents than men in both the PCMS user and non-PCMS user categories;
- The age distribution of PCMS users who responded to the post-PCMS survey was higher in the 50–59 and 60–69 age bands when compared to overall NICHE PCMS participation and the adult population of Norfolk Island as reported in the 2016 census; and

- The age distribution of non-PCMS users who responded to the post-PCMS survey was higher in the 70–79 and 80+ age bands when compared to overall NICHE PCMS participation and the adult population of Norfolk Island as reported in the 2016 census.

The sample size of the pre-PCMS analysis allowed for moderation by gender and revealed that there were slight differences, most notably that *Self Heath Evaluation* was found to only be a significant predictor of *Usage Intentions towards a PCTS* for women (Hendry et al., 2016). However, owing to the reduced sample size of the post-PCMS analysis, moderation by gender was not possible. For the same reason, moderation by age was also not possible. The literature shows that women are more likely to show concern about, and willingness to take action on climate change, while older people are more likely to have sceptical views of anthropogenic climate change (see Section 2.3.2.2). Therefore, it is possible that the higher proportion of women responding to the post-PCMS survey, together with the age distributions differences of the survey respondents as outlined above could have had an impact on the results of the analysis.

The NICHE PCMS was based upon the most well-developed conceptual downstream PCT schemes and included the usage of a carbon card, the production of carbon footprint statements, and the identification of a carbon footprint reduction target. However, as there was no carbon trading component, there were no financial penalties for above-allowance emitters, or rewards for below-allowance emitters. This may have led to a lack of understanding of the potential financial benefits of PCT for below-allowance emitters, and those willing to act as such. The lack of a financial incentive also removed the main non-environmental motivation of all of the PCT schemes for above-allowance emitters to actively reduce their carbon footprint. Given that the literature shows that financial reasons can be a considerable motivator for environmental behaviours (see Section 2.3.3.1), this would have affected the findings of the study and the ability to apply the findings to future PCT research. It is also possible that it affected participation rates among those anthropogenic climate change believers who did not voluntarily take part in the NICHE PCMS trial (see Section 6.3.4.1) and may explain the differences found when compared to previous research (see Section 6.3.2).

The relatively short length of the NICHE PCMS trial necessitated the introduction of a large reduction target after only six months of baseline data collection, as opposed to a series of smaller increments over an extended period of time. While unavoidable, this may this have led to a misconception among some above-allowance emitters about how much and how quickly they would be required to reduce their carbon footprint, and, as a result, have to pay for extra carbon allowances under a PCT scheme. This may explain why there was a significant decrease in support for a cost for increased carbon emissions following the NICHE PCMS trial (see Section 4.3.2), which could have impacted the public acceptability of PCT (see Section 6.3.3). Ideally, the NICHE PCMS trial would have been conducted over a longer period of time, thereby allowing for the gradual introduction of a reduction target, in conjunction with better education about the cost of being an above-allowance emitter.

7.5 Future Research

As Norfolk Island is a closed system where the energy consumption, transportation, and all inputs and outputs could be easily measured, and is demographically, economically and culturally similar to Australia, it was an ideal environment for a voluntary PCMS trial. However, the unique nature of Norfolk Island meant that there were some limitations that could have affected the results of the study that need to be explored further. A larger trial in a different location where the population is less resource-conscious is required to support more detailed analysis and confirm the findings of the current research. In particular, the following areas were identified as warranting further research in Section 6.2 of the previous chapter when the three research questions were discussed:

- Conduct a similar trial with identifying survey data to allow for a comparison of pre and post attitudes for users and non-users, rather than all survey respondents as was the case in the current research (see Section 6.2.1);
- Further explore the relationship between attitudes towards PCT and attitudes towards bodyweight for those who would not voluntarily use a PCMS (see Sections 6.2.2 and 6.3.1);
- Confirm the factors that influenced the *Usage Behaviour of the NICHE PCMS* using a larger sample size, thereby allowing for the simultaneous analysis of all the variables in the model instead of in smaller groups as was the case in the current research (see Section 6.2.3);

The following areas were identified as warranting further research in Section 6.3 of the previous chapter when the broader objectives of the NICHE project and the additional key findings that were identified during the investigation were discussed:

- Further explore the relationship between carbon footprint size, climate change concern, and voluntary PCMS usage that were found to be at odds with prior research, and determine if the findings of the current research are due to the unique nature of Norfolk Island, the lack of financial incentives or penalties for carbon footprint size in the current research, or indicative of wider behaviours (see Section 6.3.2);
- Confirm if the non-significance of environmental behaviours not related to carbon emissions and climate change in predicting attitudes towards PCT for PCMS-users and non-PCMS users, and voluntary PCMS usage, is due to the unique nature of Norfolk Island or whether other attitudes negate its influence (see Section 6.3.2);
- Examine options to educate households on the need for schemes that place a cost on carbon emissions (see Section 6.3.3);
- Identify additional strategies to improve the acceptability of PCT, particularly among those individuals who neither support nor oppose mandatory usage or carbon pricing (see Section 6.3.3);
- Examine why individuals who believe in anthropogenic climate change would not voluntarily participate in a PCMS trial and identify potential strategies to improve the acceptability of PCMS among them (see Section 6.3.4.1);

- Explore differing opinions on the causes of climate change and the value of a PCMS within households (see Section 6.3.4.2);
- Explore the role that descriptive norms and injunctive norms play in voluntary PCMS usage (see Section 6.3.4.2); and
- Examine what influence the gender and age moderators from the UTAUT technology acceptance model have on usage behaviour of a PCMS (see Section 6.3.5).

The following areas were identified as warranting further research in Section 6.4 of the previous chapter when the recommendations for future PCTS/PCMS trials were made:

- Identify how a larger system could be developed if access was gained to the EFTPOS banking infrastructure and assess how such a system could be implemented in order to get an exact carbon footprint of the user (see Section 6.4); and
- Identify what level of user involvement would be acceptable to most users in a larger PCTS/PCMS trial (see Section 6.4).

Finally, as discussed in Section 6.4 and in the previous section, a major limitation of the research was the inability to implement the trading component of a PCTS and the relatively short duration of the NICHE PCMS trial. While the current research was able to demonstrate the benefits of the non-financial aspects of PCT, such as improved carbon literacy and a reduction in household carbon emissions, any additional research of this nature should:

- Include trading, or some sort of financial reward or penalty for above and below-allowance emitters to examine the financial aspects of PCT; and
- Operate over a longer period of time to allow for the introduction of more gradual emissions reduction targets.

7.6 Chapter Summary

The research conducted for this thesis has made a distinct contribution to the general body of knowledge surrounding PCT and has provided crucial practical evidence that was lacking in the existing research. While additional research is required to determine whether some of the findings could be extrapolated to other populations and countries, the research presented in this thesis provides future researchers with a starting point to predict PCT attitudes and voluntary PCMS usage in a larger population sample. The differences found between those who would voluntarily use a PCMS, and those who would not, is highly relevant for researchers, community groups and lobbyists seeking to identify better communication strategies that target sections of the population, with the goal of improving the acceptability and support for the implementation of PCT.

While the NICHE PCMS did not facilitate the trading of carbon allowances, the research conducted for this thesis provided valuable evidence of the potential benefits of a PCMS. As a proof of concept study, it has highlighted the need for further research into voluntary PCMS usage. The results of the research show that the NICHE PCMS trial changed the user’s attitudes towards carbon emissions and climate change. These findings demonstrate the importance of carbon emissions monitoring as a part of overall efforts to reduce carbon emissions and highlight the need for voluntary carbon emissions monitoring systems on a much broader scale to allow any household to easily track their carbon footprint.

At the present time, mandatory usage and support for a carbon price were not found to be acceptable to the majority of survey respondents. However, the continued usage of voluntary carbon emissions monitoring systems by progressively larger sections of the population could be instrumental in communicating the role of personal energy use in contributing to climate change, thereby increasing the acceptability of PCT as a means of reducing national carbon emissions.

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Appendix A Pre-PCMS and Post-PCMS Survey Item Comparison

This appendix contains the survey items that were relevant to the research and includes**:**

- The survey item identifiers for the pre-PCMS and post-PCMS survey items as these changed for some of the survey items in the post-PCMS survey;
- The difference in wording for those questions that were re-phrased in the post-PCMS survey (highlighted in yellow);
- The additional survey items in the post-PCMS survey; and
- Identification of the survey items that were only answered by PCMS users in the post-PCMS survey (identified in the "Post-PCMS Respondents" column).

Pre-PCMS Survey Item	Post-PCMS Survey Item	Post-PCMS Respondents
A1. What is you gender?	A4. What is you gender?	All
A2. What was your year of birth?	A5. What was your year of birth?	All
A3. What is the highest level of education you have completed?	A6. What is the highest level of education you have completed?	All
A6. Compared to others on Norfolk Island, do you think your carbon footprint is/would be	A7. Compared to others on Norfolk Island, do you think your carbon footprint is/would be	All
A9. Do you generally consider your health to be	A8. Do you generally consider your health to be	All
A10. How would you best describe yourself?	A9. How would you best describe yourself?	All
A12. Compared to others on the island of similar age and gender do you consider your body weight to be	A11. Compared to others on the island of similar age and gender, do you consider your body weight to be	All
B1. I buy environmentally friendly products as much as I can	B1. I buy environmentally friendly products as much as I can	All

B2. Technology will solve future environmental problems	B2. Technology will solve future environmental problems	All
B3. Being overweight can have serious health effects	B3. Being overweight can have serious health effects	All
B4. Obesity will be solved in the future by medical advances	B4. Obesity will be solved in the future by medical advances	All
B5. It is important for me to have a low carbon footprint	B5. It is important for me to have a low carbon footprint	All
B6. A financial incentive would encourage me to reduce my environmental impact	B6. A financial incentive would encourage me to reduce my environmental impact	All
B7. Collectively, households can reduce the impacts of greenhouse gas emissions	B7. Collectively, households can reduce the impacts of greenhouse gas emissions	All
B8. I always try to eat healthy food	B8. I always try to eat healthy food	All
B9. I am confident I could maintain a healthy body weight if I wanted to	B9. I am confident I could maintain a healthy body weight if I wanted to	All
B11. Walking or cycling instead of using the car can help reduce a person's weight	B11. Walking or cycling instead of using the car can help reduce a person's weight	All
B12. I am unlikely to ever be obese	B12. I am unlikely to ever be obese	All
B13. I am worried about climate change	B13. I am worried about climate change	All
NA	B14. I am confident I could maintain a low carbon footprint if I wanted to	All
B14. I turn the tap off when cleaning my teeth	B15. I turn the tap off when cleaning my teeth	All
B15. I turn lights off when not in use	B16. I turn lights off when not in use	All
B16. I sort my rubbish	B17. I sort my rubbish	All
B17. I look to buy second hand over brand new	B18. I look to buy second hand over brand new	All
B18. I consciously try to reduce waste and recycle	B19. I consciously try to reduce waste and recycle	All
B19.I buy local produce, even if imported is cheaper	B20. I buy local produce, even if imported is cheaper	All
C1. How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?	C1. How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?	All
E1. Being able to measure my carbon footprint is important to me	F1. Being able to measure my carbon footprint is important to me	All

E2. Most people would accept a PCT system as a tool for improving the environment	F5. Most people would accept the NICHE carbon card system as a tool for improving the environment	All
E3. A PCT system would encourage me to reduce my carbon footprint	F18. The NICHE carbon card system has encouraged me to reduce my carbon footprint	PCMS users
E4. A PCT system would encourage me to walk or cycle more and drive less	F19. The NICHE carbon card system has encouraged me to walk or cycle more and drive less	PCMS users
E5. People who reduce their carbon footprint should be rewarded in some way	F7. People who reduce their carbon footprint should be rewarded in some way	All
E6. People with a greater carbon footprint should have to pay for it in some way	F8. People with a greater carbon footprint should have to pay for it in some way	All
E7. A PCT system would encourage me to eat more healthy, locally grown produce	NA	
E8. A PCT system would be useful for me to help monitor my environmental impact	F20. The NICHE carbon card system has helped me to monitor my environmental impact	PCMS users
E9. Comparing my carbon usage to the average would influence my consumption habits	F21. Comparing my household's carbon usage to the NICHE household average influenced my consumption habits	PCMS users
E10. There is a strong link between a person's carbon footprint and their health	D22. There is a strong link between a person's carbon footprint and their health	All
F3. How many people live in your house? How many Adults (>18yrs)? How many Children (<18 yrs)?	E2. How many people live in your house? How many Adults (>18yrs)? How many Children (<18 yrs)?	All
F22. Roughly, what is your total weekly household income from all sources?	E12. Roughly, what is your total weekly household income from all sources?	All
F23. What best describes your thoughts about climate change?	E13. What best describes your thoughts about climate change?	All
NA	F2. I was encouraged to use the NICHE carbon card system by my household	All
NA	F3. I was encouraged to use the NICHE carbon card system by the petrol station operators	All

NA	F4. There was pressure from the community to use the NICHE carbon card system	All
NA	F6. It should be compulsory for people to monitor the size of their carbon footprint	All
NA	F9. I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island	All
NA	F10. Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?	All
NA	F13. It was easy to use the NICHE carbon card at the petrol station	PCMS users
NA	F14. It has been a valuable use of my time to review the size of my household's carbon footprint	PCMS users
NA	F15. Being able to review information about the size of my carbon footprint has saved me money	PCMS users
NA	F16. The information about my households carbon footprint provided by the NICHE carbon card system was very useful	PCMS users
NA	F17. Using the NICHE carbon card system has made me more aware of my carbon footprint	PCMS users
NA	F22. Comparing my household's carbon usage to the NICHE Target influenced my consumption habits	PCMS users
NA	F23. If it was still available I would continue to use the NICHE carbon card system to monitor my personal carbon footprint (when answering this question assume that there are no fuel discounts)	PCMS users

Appendix B Pre-PCMS Survey

This appendix contains a copy of the pre-PCMS survey.

General Information

These first questions are designed to find out a bit about you and your feelings	
A1. What is you gender?	Male ☐ Female ☐
A2. What was your year of birth?	19 _____
A3. What is the highest level of education you have completed?	☐ Less than primary ☐ Primary school ☐ Secondary School ☐ High school ☐ College/University ☐ Post graduate
A4. In the past 12 months did you catch or produce any of the following for your own consumption? If so, roughly what percentage of your annual household consumption of this food did this make up? (write in the percentage)	☐ Fruit _______% ☐ Vegetables _______% ☐ Eggs _______% ☐ Meat _______% ☐ Fish/seafood _______%
A5. Which of the following items do you use at your primary Residence? (circle as many numbers as apply).	☐ Water tank ☐ Solar hot water ☐ Gas hot water ☐ Gas cooking ☐ Gas heater ☐ Wood fireplace
A person's 'carbon footprint' is the amount of greenhouse gas emissions, expressed as carbon dioxide equivalents (CO_{2}-e) involved with a person's activities over a year.	
A6. Compared to others on Norfolk Island, do you think your carbon footprint is/would be….	☐ Well below average ☐ Below average ☐ About average ☐ Above average

	☐ Well above average
A7. Which of these activities do you think contributes the most to your carbon footprint?	☐ Transportation ☐ Electricity ☐ Heating/cooling ☐ Production of food /drink ☐ Waste disposal ☐ Plane flights
A8. Which of these activities do you think contributes the most to the world's carbon footprint?	☐ Transportation ☐ Electricity ☐ Heating/cooling ☐ Production of food /drink ☐ Waste disposal ☐ Plane flights
And now some questions about your health	
A9. Do you generally consider your health to be………	☐ Poor ☐ Fair ☐ Good ☐ Very good ☐ Excellent
A10. How would you best describe yourself?	☐ Very underweight ☐ A bit underweight ☐ Healthy weight ☐ A bit overweight ☐ Very overweight
A11. What is your height and weight	Height ______m _____cm Weight ______kg
A12. Compared to others on the island of similar age and gender do you consider your body weight to be….	☐ Well below average ☐ Below average ☐ About average ☐ Above average ☐ Well above average
A13. What do you think would be your most healthy body weight?	____kg

Attitudes

Your views about health and the environment are important. Please state to what extent you agree or disagree with the following statements (circle a number)	
	Strongly Agree — Neutral — Strongly Disagree
B1. I buy environmentally friendly products as much as I can.	1____2____3____4____5____6____7
B2. Technology will solve future environmental problems	1____2____3____4____5____6____7
B3. Being overweight can have serious health effects	1____2____3____4____5____6____7
B4. Obesity will be solved in the future by medical advances	1____2____3____4____5____6____7
B5. It is important for me to have a low carbon footprint	1____2____3____4____5____6____7
B6. A financial incentive would encourage me to reduce my environmental impact	1____2____3____4____5____6____7
B7. Collectively, households can reduce the impacts of greenhouse gas emissions	1____2____3____4____5____6____7
B8. I always try to eat healthy food	1____2____3____4____5____6____7
B9. I am confident I could maintain a healthy body weight if I wanted to	1____2____3____4____5____6____7
B10. I would consider purchasing an electric car or bike if the price was right	1____2____3____4____5____6____7
B11. Walking or cycling instead of using the car can help reduce a person's weight	1____2____3____4____5____6____7
B12. I am unlikely to ever be obese	1____2____3____4____5____6____7
B13. I am worried about climate change	1____2____3____4____5____6____7
….. and some questions about your behaviours	Never — Sometimes — Always
B14. I turn the tap off when cleaning my teeth	1____2____3____4____5____6____7
B15. I turn lights off when not in use	1____2____3____4____5____6____7

B16. I sort my rubbish	1_____2____3_____4____5_____6____7
B17. I look to buy second hand over brand new	1_____2____3_____4____5_____6____7
B18. I consciously try to reduce waste and recycle	1_____2____3_____4____5_____6____7
B19.I buy local produce, even if imported is cheaper	1_____2____3_____4____5_____6____7
B20. I use the toy library for my kids/grandkids (leave blank if not applicable)	1_____2____3_____4____5_____6____7

Physical activity

These questions give us an idea of your activity levels	
C1. How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?	☐ Daily ☐ 3-5 times/week ☐ 1-3 times/week ☐ < once a week ☐ Never
C2. Do you ever walk or use a bicycle for at least 10 minutes continuously to get to and from places? (If no go to question C5)	☐ Yes walk ☐ Yes cycle ☐ No
C3. In a typical week, how many days do you walk or bicycle for least 10 minutes to get to and from places?	______ days a week
C4. How much time (in hours &/or minutes) would you spend walking or cycling to and from places on a typical day?	_____ hrs ______mins
C5. Are you employed outside your home? (if no go to question C8)	☐ Yes ☐ No – work at home ☐ No – don't work
C6. Approximately how far is it to your usual place of work?	______km or ______ metres ☐ varies
C7. How do you usually get to and from work?	☐ Drive car ☐ Motorbike ☐ Car pool ☐ Cycle

	☐ Walk
C8. Do you have school age children? (If no, go to question C13)	☐ Yes ☐ No
C9. If you have children in infant's school how do they normally to and from school? (most common method) (If no children of this age, leave blank)	☐ Driven by car ☐ Walk ☐ Cycle ☐Car pool
C10. If you have children in primary school to year 8 how do the normally get to and from school? (most common method) (If no children of this age, leave blank)	☐ Driven by car ☐ Walk ☐ Cycle ☐Car pool
C11. If you have children in years 9 to 12 how do they normally get to and from school? (most common method) (If no children of this age, leave blank)	☐ Driven by car ☐ Walk ☐ Cycle ☐ Motor-bike ☐ Drive themselves ☐ Car pool
C12. Approximately how many km (or metres) is it to school?	________ km or _______ Metres
C13. If you had to travel from Norfolk Mall to the ATM, how would you usually do it?	☐ Car ☐ Walk ☐ Cycle ☐ Get a lift
C14. If you had to travel from Emily Bay to Kingston Pier, how would you usually do it?	☐ Car ☐ Walk ☐ Cycle ☐ Get a lift
C15. Before the recent petrol shortage, did you ever car pool if going to a meeting or event with others?	☐ Never ☐ Rarely ☐ Sometimes ☐ Often

Nutrition

… and now some questions about what you eat and drink					
Thinking about your eating habits on most days, how often would you consume each of the following?	Rarely or Never	1-3 times a month	1-3 times a week	4-6 times a week	Usually Daily
D1. Pastries, croissants, muffins, doughnuts, cake or sweet biscuits					
D2**. Imported** soft drink, or fruit juice					
D3. **Local** soft drink or fruit juice					
D4. Full fat milk or cream (more than 1/2 cup)					
D5. Low fat milk or cream (more than 1/2 cup)					
D6. Ice cream					
D7. Chocolate, chocolate biscuits or sweet snack					
D8. Canned fruit/dried fruit (2 or more pieces)					
D9. Chips, crisps or corn chips					
D10. Rice crackers, nuts, popcorn, seeds					
D11. Yoghurt, sorbet, frozen fruit					
D12. Canned or frozen vegetables					
D13. **Fresh local** fruit and vegetables/salad pack					
D14. **Imported** meat					
D15. **Local** meat					
D16. High sugared breakfast cereals (e.g. Nutrigrain; Coco-pops etc)					
D17. Porridge/Muesli/Weetbix					
D18. White bread					
D19. Grain/wholemeal bread					
D20. Packaged meals/instant noodles					
D21. Homemade noodle dishes					

D22. Oils (safflower; sunflower)					
D23. Oils (olive/canola/peanut)					
D24. **Local** fish/crustaceans (e.g. hihi)					
D25. **Imported** fish					
D26. Tahitian fish					
D27. Pilahai (banana bake)					
D28. Poi (banana/pumpkin and arrowroot)					
D29. Mudda					
D30. Green plun fritters					
D31. Coconut bread/coconut pie					

Personal Carbon Trading

Regardless of your views around climate change, most developed countries around the world have agreed that they need to reduce greenhouse gas emissions to help maintain a sustainable future. One of the proposed methods is based on a concept known as Personal Carbon Trading (PCT).

PCT unlike a carbon tax, is designed so that individuals can take responsibility for their own behaviour. Under this system, a national carbon emission target is set, following which all adults are given a personal carbon allowance with the same number of carbon units. When buying carbon intensive products such as fuel, electricity and some highly processed foods, units come off your allowance, so that at the end of a set period, if you are left with units, you can cash these in. The account would allow you to track your usage and compare yourself to the average. If you wanted or needed to use more units than you are given, you could obtain extra from those using less.

We're interested in your views on this approach to reducing carbon emissions and the potential for improving health. For example, would it encourage more physical activity and a better diet? Please place a circle around the score on the following questions that most represents your view about this:

Circle the number on the following statements that best represents your view	
	Strongly Agree / Neutral / Strongly Disagree
E1. Being able to measure my carbon footprint is important to me	1_____2____3_____4____5_____6____7
E2. Most people would accept a PCT system as a tool for improving the environment	1_____2____3_____4____5_____6____7
E3. A PCT system would encourage me to reduce my carbon footprint	1_____2____3_____4____5_____6____7
E4. A PCT system would encourage me to walk or cycle more and drive less	1_____2____3_____4____5_____6____7
E5. People who reduce their carbon footprint should be rewarded in some way	1_____2____3_____4____5_____6____7
E6. People with a greater carbon footprint should have to pay for it in some way	1_____2____3_____4____5_____6____7
E7. A PCT system would encourage me to eat more healthy, locally grown produce	1_____2____3_____4____5_____6____7
E8. A PCT system would be useful for me to help monitor my environmental impact	1_____2____3_____4____5_____6____7
E9. Comparing my carbon usage to the average would influence my consumption habits	1_____2____3_____4____5_____6____7
E10. There is a strong link between a person's carbon footprint and their health	1_____2____3_____4____5_____6____7

Demographic data

And finally, some questions about yourself	
F1. Do you rent your primary residence?	☐ Yes

	☐ No
F2. Which best describes your current residential status on Norfolk Island?	☐ TEP ☐ GEP ☐ Resident ☐ Temporary visitor
F3. How many people live in your house? How many Adults (>18yrs)? How many Children (<18 yrs)?	Total ________ Number ______ Number ______
F4. How many motor vehicles are there in the household (if any)? Cars/vans Motorbikes Trucks/Utes	 Number ______ Number ______ Number ______
F5. How many of these are registered **business** vehicles? (If zero, go to question F7)	Number ______
F6. What percentage of those vehicle expenses do you normally claim as a business expense?	_________%
F7. How many bicycles are there in the household (if any)?	Number ______
F8. How many months would it take you to use a full gas bottle in your house?	Number ______
F9. How many small (BBQ) gas bottles do you use yearly?	Number ______
F10. Roughly, what is your electricity cost per quarter in your primary residence?	☐ $0 - $300 ☐ $301- $600 ☐ $601 - $900 ☐ $901 - $1200 ☐ $1200+
F11. Do you own a business that generates income out of this residence?	☐ Yes ☐ No
F12. If yes, about what proportion of your electricity costs would be related to business?	_______%
F13. Do you have solar **hot water** in your primary residence? (if no, go to question F15)	☐ Yes ☐ No

F14. If yes, how long have you had it?	☐ 0-6 months ☐ 6-12 months ☐ 1 – 2 years ☐ 2 years +
F15. Do you have solar panels or wind turbines that generate electricity at your primary residence? (if no, skip to question F19)	☐ Yes ☐ No
F16. If yes, how long have you had these?	☐ 0-6 months ☐ 6-12 months ☐ 1 – 2 years ☐ 2 years +
F17. What is your main reason for using solar electricity/wind turbines (rank from 1, most important to 4, least important)	☐ Govt Rebate ☐ Reduce power costs ☐ Environment ☐ Reliability
F 18. How many kilowatts of electricity can you generate? (if unsure leave blank)	Size _______kW
F19. Roughly, what would be the average weekly expenditure for your **entire** household on each of the following fuels?	Petrol $ ________ Diesel $ ________ Bio-fuel $________
F20. During the past 12 months how many flights have you taken off Norfolk Island to the following locations? (if none answer 0)	Australia _______ NZ _______ Other _______
F21. In the last 12 months have you made a purchase of any of the following major items? And so roughly how much did you spend on these	Car $________ Renovations $________ TV/video etc $________ Other $________
F22. Roughly, what is your total weekly household income from all sources?	☐ <$500 ☐ $501- 1000 ☐ $1001-1500 ☐ $1501-2000 ☐ >$2000

F23. What best describes your thoughts about climate change?

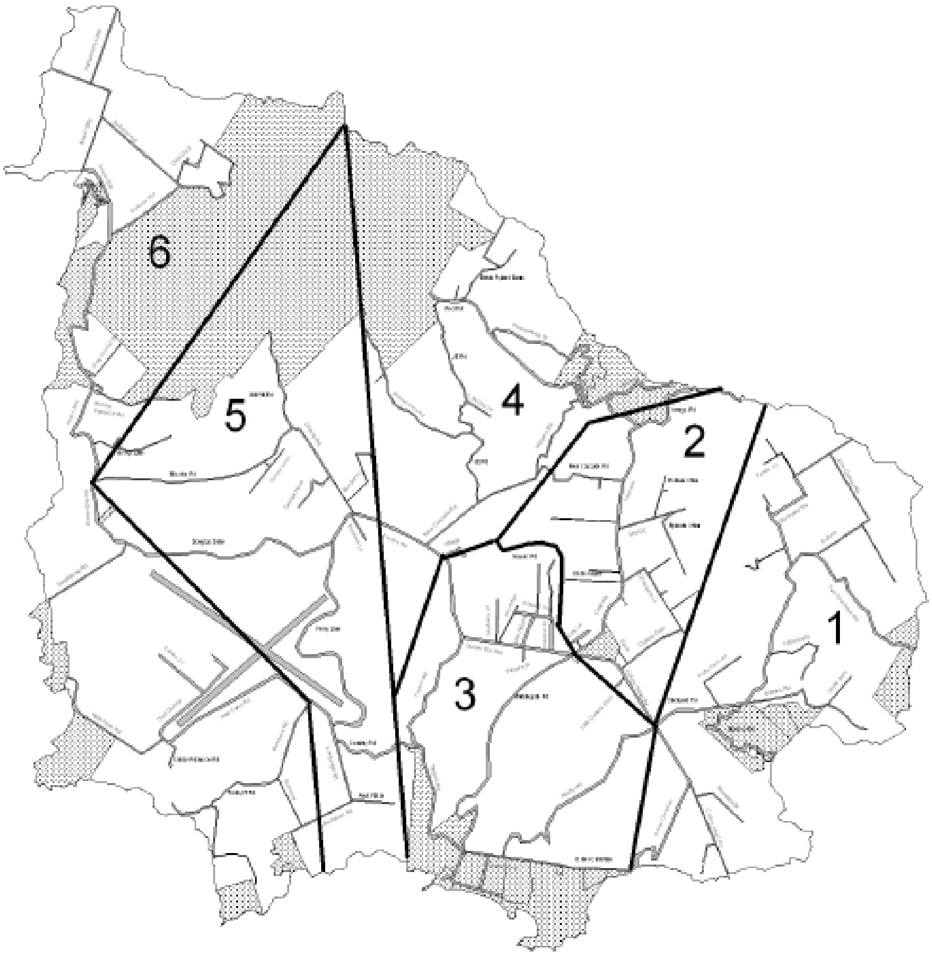
- [ ] I don't think climate change is happening
- [ ] I have no idea whether climate change is happening or not
- [ ] I think climate change is happening but it's a natural fluctuation in earth temperatures
- [ ] I think climate change is happening and I think humans are largely causing it

Appendix C Post-PCMS Survey

This appendix contains a copy of the post-PCMS survey.

<u>Questions about you</u>

A1) Looking at the map and descriptions below which region do you currently live?



Please tick which region you live, if you are unsure please guess.

☐ **Region 1** - Steeles Point to Rainbows End, including Driver Christian Rd.

☐ **Region 2** – Cascade Area. Including Collins Head Rd from Satties Corner to Middlegate intersection to the Harpers Rd intersection.

☐ **Region 3** – Middlegate to Kingston, including Short Ridge and Burnt Pine to The Village ending at the Country Rd/Water Mill Intersection.

☐ **Region 4** – New Cascade Area. Palm Glen to Prince Philip ending in Burnt Pine between The Village and the Bicentennial Complex.

☐ **Region 5** – Mission Rd to the Bicentennial complex in Burnt Pine. Beef Steak to Bumbora Rd intersection and to the cattle stop on Douglas Dr.

☐ **Region 6** – Anson, 100 Acres, Rocky Point to Bumbora Rd intersection.

A2) Did you complete the NICHE Household Survey in March 2012?	☐ Yes ☐ No, skip to Question A4
A3) Are you living in the same region now as you did when you completed the NICHE Household Survey in March 2012?	☐ Yes ☐ No
A4) What is you gender?	Male ☐ Female ☐
A5) What was your year of birth?	19 _____
A6) What is the highest level of education you have completed?	☐ Less than primary ☐ Primary school ☐ Secondary School ☐ High school ☐ College/University ☐ Post graduate
A person's 'carbon footprint' is the amount of greenhouse gas emissions, expressed as carbon dioxide equivalents (CO_2-e) involved with a person's activities over a year.	

A7) Compared to others on Norfolk Island, do you think your carbon footprint is/would be	☐ Well below average ☐ Below average ☐ About average ☐ Above average ☐ Well above average
And now some questions about your health	
A8) Do you generally consider your health to be………	☐ Poor ☐ Fair ☐ Good ☐ Very good ☐ Excellent
A9) How would you best describe yourself?	☐ Very underweight ☐ A bit underweight ☐ Healthy weight ☐ A bit overweight ☐ Very overweight
A10) What is your height and weight	Height ______m _____cm Weight ______kg
A11) Compared to others on the island of similar age and gender, do you consider your body weight to be…..	☐ Well below average ☐ Below average ☐ About average ☐ Above average ☐ Well above average

<u>Attitudes</u>

Your views about health and the environment are important. Please state to what extent you agree or disagree with the following statements (circle a number)	
	Strongly Agree Neutral Strongly Disagree
B1) I buy environmentally friendly products as much as I can.	1____2____3____4____5____6____7
B2) Technology will solve future environmental problems.	1____2____3____4____5____6____7

B3) Being overweight can have serious health effects.	1____2____3____4____5____6____7
B4) Obesity will be solved in the future by medical advances.	1____2____3____4____5____6____7
B5) It is important for me to have a low carbon footprint.	1____2____3____4____5____6____7
B6) A financial incentive would encourage me to reduce my environmental impact.	1____2____3____4____5____6____7
B7) Collectively, households can reduce the impacts of greenhouse gas emissions.	1____2____3____4____5____6____7
B8) I always try to eat healthy food.	1____2____3____4____5____6____7
B9) I am confident I could maintain a healthy body weight if I wanted to.	1____2____3____4____5____6____7
B10) I would consider purchasing an electric car or bike if the price was right.	1____2____3____4____5____6____7
B11) Walking or cycling instead of using the car can help reduce a person's weight.	1____2____3____4____5____6____7
B12) I am unlikely to ever be obese.	1____2____3____4____5____6____7
B13) I am worried about climate change.	1____2____3____4____5____6____7
B14) I am confident I could maintain a low carbon footprint if I wanted to.	1____2____3____4____5____6____7
….. and some questions about your behaviours	Never Sometimes Always
B15) I turn the tap off when cleaning my teeth.	1____2____3____4____5____6____7
B16) I turn lights off when not in use.	1____2____3____4____5____6____7
B17) I sort my rubbish.	1____2____3____4____5____6____7
B18) I look to buy second hand over brand new.	1____2____3____4____5____6____7
B19) I consciously try to reduce waste and recycle.	1____2____3____4____5____6____7
B20) I buy local produce, even if imported is cheaper.	1____2____3____4____5____6____7

Physical activity

These questions give us an idea of your activity levels	
C1) How often do you engage in leisure time physical activity for the sole purpose of improving or maintaining your health?	☐ Daily ☐ 3-5 times/week ☐ 1-3 times/week ☐ < once a week ☐ Never
C2) Do you ever walk or use a bicycle for at least 10 minutes continuously to get to and from places? (If no go to question C5)	☐ Yes walk ☐ Yes cycle ☐ No
C3) In a typical week, how many days do you walk or bicycle for at least 10 minutes to get to and from places?	______ days a week
C4) How much time (in hours &/or minutes) would you spend walking or cycling to and from places on a typical day?	_____ hrs ______mins
C5) Are you employed outside your home? (if no go to question C8)	☐ Yes ☐ No – work at home ☐ No – don't work
C6) Approximately how far is it to your usual place of work?	______km or ______ metres ☐ varies
C7) How do you usually get to and from work?	☐ Drive car ☐ Motorbike ☐ Car pool ☐ Cycle ☐ Walk
C8) Do you have school age children? (If no, go to question C13)	☐ Yes ☐ No
C9) If you have children in infant's school how do they normally get to and from school? (If no children of this age, leave blank)	☐ Driven by car ☐ Walk ☐ Cycle ☐ Car pool
C10) If you have children in primary school to year 8 how do they normally get to and from school? (If no children of this age, leave blank)	☐ Driven by car ☐ Walk ☐ Cycle ☐ Car pool

C11) If you have children in years 9 to 12 how do they normally get to and from school? (If no children of this age, leave blank)	☐ Driven by car ☐ Walk ☐ Cycle ☐ Motor-bike ☐ Drive themselves ☐ Car pool
C12) Approximately how many km (or metres) is it to school?	________ km or _______ Metres
C13) If you had to travel from Norfolk Mall to the ATM, how would you usually do it?	☐ Car ☐ Walk ☐ Cycle ☐ Get a lift
C14) If you had to travel from Emily Bay to Kingston Pier, how would you usually do it?	☐ Car ☐ Walk ☐ Cycle ☐ Get a lift
C15) How often do you car pool if going to a meeting or event with others?	☐ Never ☐ Rarely ☐ Sometimes ☐ Often

<u>Nutrition</u>

Thinking about your recent eating habits, how often would you consume each of the following?

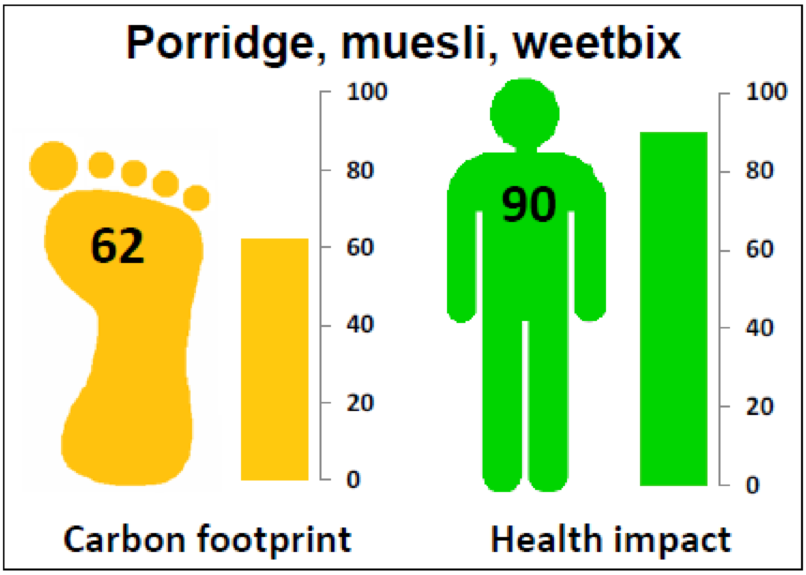
Please tick the appropriate column for each food item.	Rarely or Never	1-3 times a month	1-3 times a week	4-6 times a week	Usually Daily
D1) **Imported** soft drink, or fruit juice					
D2) **Local** soft drink or fruit juice					
D3) Full fat milk or cream (more than 1/2 cup)					

D4) Low fat milk or cream (more than 1/2 cup)					
D5) Ice cream					
D6) Chocolate, biscuits or sweet snacks					
D7) Canned fruit/dried fruit (2 or more pieces)					
D8) Chips, crisps or corn chips					
D9) Rice crackers, nuts, popcorn, seeds					
D10) Yoghurt, sorbet, frozen fruit					
D11) Canned or frozen vegetables					
D12) **Fresh local** fruit and vegetables/ salad packs					
D13) Imported meat					
D14) **Local** meat					
D15) High sugared breakfast cereals (eg. Nutri-grain; Coco-pops etc)					
D16) Porridge/Muesli/Weetbix					

NICHE Food Labels

The NICHE food labelling trial has been running in Foodland Supermarket since July 2014. During this trail some commonly purchased food items have been labelled with both a health score and a carbon footprint score. We value your opinion on the impact of these labels.

Example NICHE food label currently being trialled in Foodland Supermarket



D17) Have you seen the NICHE food labels in the Foodland Supermarket? (example above)	☐ Yes ☐ No, skip to question E1 on the next page

Please circle the number on the following statements that best represents your view	
	Strongly Agree Neutral Strongly Disagree
D18) The NICHE food labels have encouraged me to eat more healthy food products?	1____2____3____4____5____6____7
D19) The NICHE food labels have encouraged me to eat more environmentally friendly food products?	1____2____3____4____5____6____7
D20) I would like to see the NICHE food labels continue?	1____2____3____4____5____6____7
D21) The NICHE food labels have encouraged me to eat more healthy, locally grown produce?	1____2____3____4____5____6____7
D22) There is a strong link between a person's carbon footprint and their health?	1____2____3____4____5____6____7

Demographic data

E1) Which best describes your current residential status on Norfolk Island?	☐ TEP ☐ GEP ☐ UEP

	☐ Resident ☐ Temporary visitor
E2) How many people live in your house? How many Adults (>18yrs)? How many Children (<18 yrs)?	Total _______ Number ______ Number ______
E3) How many bicycles are there in the household (if any)?	Number______
E4) How many months would it take you to use a full 50kg gas bottle in your house?	Number______
E5) How many small (9kg BBQ) gas bottles do you use yearly?	Number______
E6) Roughly, what is your electricity cost per quarter in your primary residence?	☐ $0 - $300 ☐ $301- $600 ☐ $601 - $900 ☐ $901 - $1200 ☐ $1200+
E7) Do you have solar panels or wind turbines that generate electricity at your primary residence? (if no, skip to question E11)	☐ Yes ☐ No
E8) If yes, how long have you had these?	☐ 0-6 months ☐ 6-12 months ☐ 1 – 2 years ☐ 2 years +
E9) What is your main reason for using solar electricity/wind turbines (rank from 1, most important to 4, least important)	Government Rebate ___ Reduce power costs ___ Environment ___ Reliability ___
E10) How many kilowatts of electricity can you generate? (if unsure leave blank)	Size _______kW
E11) Roughly, what would be the average weekly expenditure for your **entire** household on each of the following fuels?	Petrol $ ________ Diesel $ ________ Bio-fuel $________
E12) Roughly, what is your total weekly household income from all sources?	☐ <$500 ☐ $501- 1000 ☐ $1001-1500 ☐ $1501-2000

	☐ >$2000
E13) What best describes your thoughts about climate change? ☐ I don't think climate change is happening ☐ I have no idea whether climate change is happening or not ☐ I think climate change is happening but it's a natural fluctuation in earth temperatures ☐ I think climate change is happening and I think humans are largely causing it	

Thoughts about NICHE

The NICHE carbon card system allowed participants to track their household carbon footprint (associated with fuel, electricity and gas usage) and compare their carbon footprint with the average household of similar size as well as compare to a NICHE target (based on a 10% reduction for the island). A fuel discount was used as an incentive for participants in return for their usage data.

Regardless of whether you participated in the NICHE carbon card system or not we value your opinion. Please complete the questions below based on your knowledge and/or experience of the NICHE carbon card system.

Please circle the number on the following statements that best represents your view	
	Strongly Agree Neutral Strongly Disagree
F1) Being able to measure my carbon footprint is important to me.	1____2____3____4____5____6____7
F2) I was encouraged to use the NICHE carbon card system by my household.	1____2____3____4____5____6____7
F3) I was encouraged to use the NICHE carbon card system by the petrol station operators.	1____2____3____4____5____6____7
F4) There was pressure from the community to use the NICHE carbon card system.	1____2____3____4____5____6____7
F5) Most people would accept the NICHE carbon card system as a tool for improving the environment.	1____2____3____4____5____6____7

F6) It should be compulsory for people to monitor the size of their carbon footprint.	1____2____3____4____5____6____7
F7) People who reduce their carbon footprint should be rewarded in some way.	1____2____3____4____5____6____7
F8) People with a greater carbon footprint should have to pay for it in some way.	1____2____3____4____5____6____7
F9) I would support the introduction of a mandatory NICHE carbon card system on Norfolk Island (When answering this question assume that the system is running without the fuel discounts)	1____2____3____4____5____6____7

F10) Did you or a member of your household register for a NICHE carbon card which entitled you to the NICHE fuel discount?

☐ Yes, I had a NICHE carbon card and was entitled to the fuel discount? (Go to Next question, F11)

☐ I didn't have a NICHE carbon card, but somebody else in this household did? (skip to End - Thank you / Prize draw page)

☐ No one in this household registered for the NICHE carbon card? (skip to End - Thank you / Prize draw page)

F11) What was your NICHE account number? You will find your account number on your NICHE carbon card and your NICHE statements. If unsure please write your address.	NICHE #__________________ Or Address: ______________________________ ______________________________
F12) During the NICHE trial what percentage of the time did you use your NICHE carbon card whilst purchasing fuel at the petrol station	____%

Please circle the number on the following statements that best represents your view

	Strongly Agree / Neutral / Strongly Disagree
F13) It was easy to use the NICHE carbon card at the petrol station.	1___2___3___4___5___6___7
F14) It has been a valuable use of my time to review the size of my household's carbon footprint	1___2___3___4___5___6___7
F15) Being able to review information about the size of my carbon footprint has saved me money	1___2___3___4___5___6___7
F16) The information about my households carbon footprint provided by the NICHE carbon card system was very useful.	1___2___3___4___5___6___7

F17) Using the NICHE carbon card system has made me more aware of my carbon footprint.	1___2___3___4___5___6___7
F18) The NICHE carbon card system has encouraged me to reduce my carbon footprint.	1___2___3___4___5___6___7
F19) The NICHE carbon card system has encouraged me to walk or cycle more and drive less.	1___2___3___4___5___6___7
F20) The NICHE carbon card system has helped me to monitor my environmental impact.	1___2___3___4___5___6___7
F21) Comparing my household's carbon usage to the NICHE household <u>average</u> influenced my consumption habits.	1___2___3___4___5___6___7
F22) Comparing my household's carbon usage to the NICHE <u>Target</u> influenced my consumption habits	1___2___3___4___5___6___7
F23) If it was still available I would continue to use the NICHE carbon card system to monitor my personal carbon footprint (when answering this question assume that there are no fuel discounts)	1___2___3___4___5___6___7

Appendix D NICHE PCMS Statement

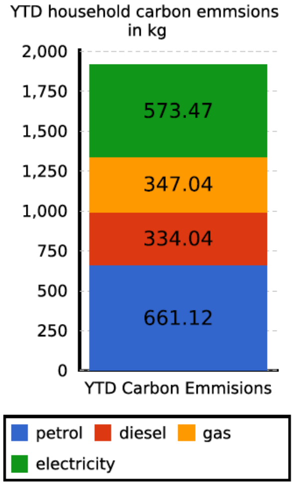
This appendix shows an example of a carbon emissions statement for a household participating in the NICHE PCMS trial.

NICHE statement for id: 739

Your household details	
Household name: [redacted]	Solar electricity: true
Number of members: 5	Solar hot water: true
Number of under 18's: 3	Gas hot water: unknown
Number of vehicles: 3	

If any of the above information is incorrect please contact Tarn or PJ

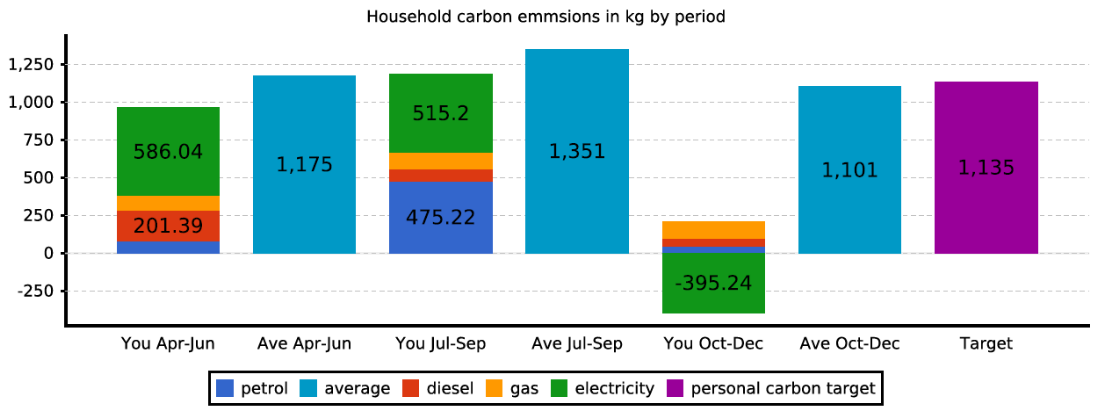
Your household carbon emission's	Average (5 members)
Apr - Jun: 965.57 kg	Apr - Jun: 1175.0 kg
Jul - Sep: 1184.18 kg	Jul - Sep: 1351.0 kg
Oct - Dec: -186.99 kg	Oct - Dec: 1101.0 kg
Your personal carbon target (5 members)	
Your target: 1135.0 kg	



The Personal Carbon Target is calculated based on a percentage of the average compliant household (with the same number of people). The target is based on what the research team has calculated to have a potential impact on improving the environment and potentially health. The target is voluntary however all participants are encourage to work towards being below the target such that the research team can better understand what impact, if any it will have.

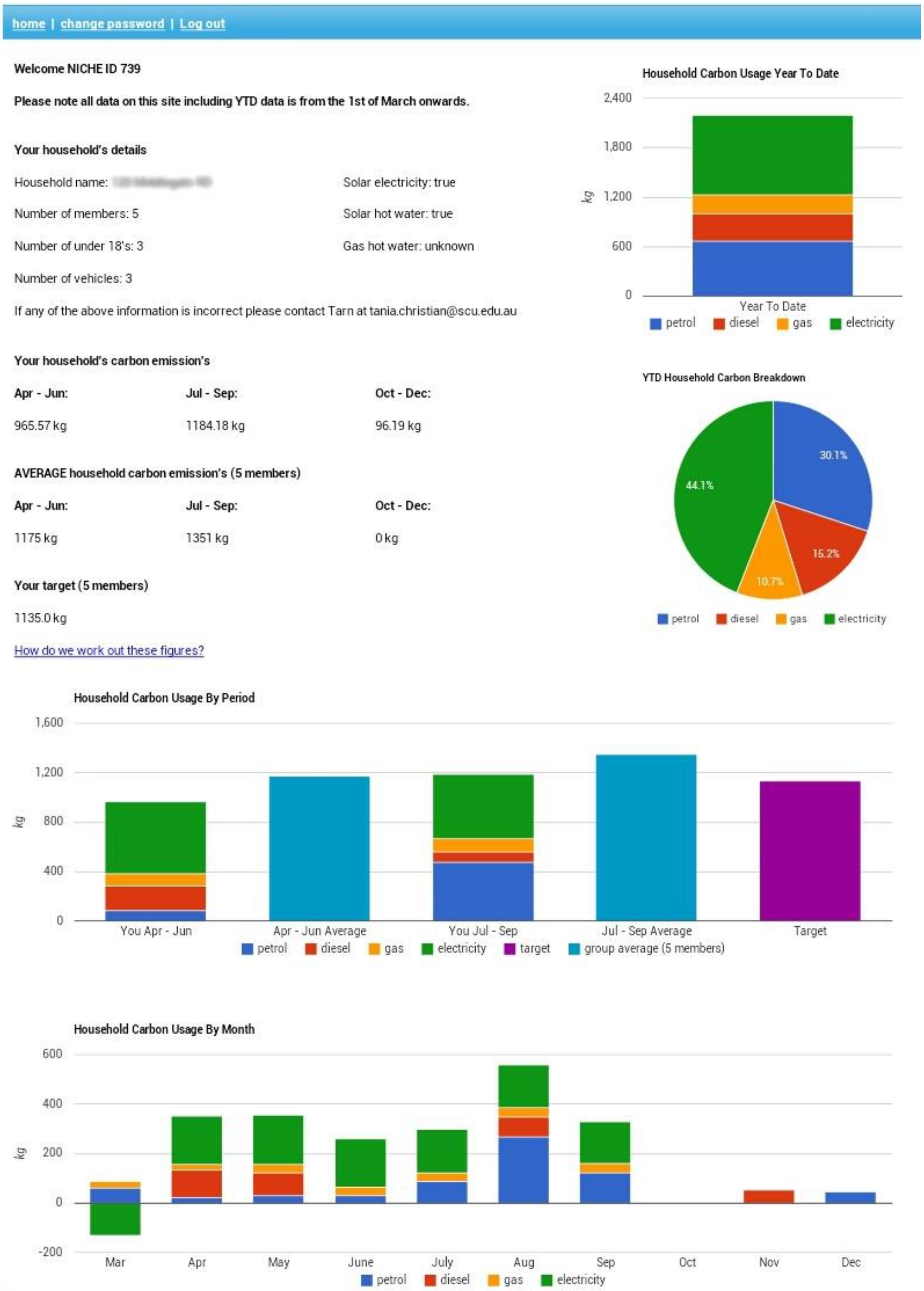
Whilst the goal is to reduce your carbon footprint, you are not encouraged to adopt any behaviour that you consider unsafe or that would have a significant negative impact on your quality of life.

Please note all data on this statement including YTD data is from the 01/03/13 and with the exception of the purchases on your card listed below all data is household data. For more in depth information or to see how these figures were calculated please log into your account on the NICHE website at www.nicheaccount.com



Appendix E NICHE PCMS Users Website

This appendix shows a screenshot of the end-user's website for a household participating in the NICHE PCMS trial. The screenshot was taken in the October - December 2013 quarter before the electricity data was collected.



Appendix F Exploratory Factor Analysis

This appendix contains the outputs of the EFA that were discussed in Section 5.3.

F.1 Post-PCMS PCTS Attitudes

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.717
Bartlett's Test of Sphericity	Approx. Chi-Square	115.366
	Df	10
	Sig.	.000

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.277	45.533	45.533	1.660	33.206	33.206
2	1.049	20.976	66.509			
3	.650	12.990	79.499			
4	.573	11.458	90.957			
5	.452	9.043	100.000			

Extraction Method: Principal Axis Factoring.

Factor Matrix[a]

	Factor
	1
F5	.692
F1	.682
D22	.616
F8	.472

F7	.336

Extraction Method: Principal Axis Factoring.

a. 1 factors extracted. 7 iterations required.

F.2 Post-PCMS Usage Behaviour of the NICHE PCMS

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.773
	Approx. Chi-Square	431.287
Bartlett's Test of Sphericity	Df	15
	Sig.	.000

a. Only cases for which F10 = 1 are used in the analysis phase.

Total Variance Explained[a]

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.362	72.702	72.702	4.053	67.556	67.556
2	.668	11.128	83.830			
3	.495	8.245	92.075			
4	.268	4.465	96.540			
5	.153	2.551	99.091			
6	.055	.909	100.000			

Extraction Method: Principal Axis Factoring.

a. Only cases for which F10 = 1 are used in the analysis phase.

Factor Matrix[a,b]

	Factor
	1

F22	.903
F21	.882
F18	.825
F17	.824
F20	.796
F19	.685

Extraction Method: Principal Axis Factoring.

a. 1 factors extracted. 5 iterations required.

b. Only cases for which F10 = 1 are used in the analysis phase.

F.3 Post-PCMS Attitudes towards Health, the Environment, Carbon Emissions and Climate Change

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.771
Bartlett's Test of Sphericity	Approx. Chi-Square	464.882
	Df	55
	Sig.	.000

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.661	33.280	33.280	3.217	29.246	29.246	2.598
2	1.448	13.167	46.448	1.037	9.428	38.674	1.163

3	1.204	10.949	57.396	.770	7.003	45.677	1.862
4	1.030	9.367	66.763	.528	4.802	50.479	1.700
5	.782	7.107	73.870				
6	.651	5.920	79.790				
7	.600	5.458	85.248				
8	.515	4.684	89.932				
9	.448	4.076	94.009				
10	.378	3.440	97.449				
11	.281	2.551	100.000				

Extraction Method: Principal Axis Factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Pattern Matrix[a]

	Factor			
	1	2	3	4
B1	.755	.022	.046	-.081
B5	.667	.086	-.082	.359
B8	.592	.060	.241	-.114
B4	-.031	.895	-.039	-.071
B2	.066	.460	.031	.071
B9	-.121	.009	.895	.247
B12	.137	.005	.555	-.134
B7	.462	-.039	-.078	.525
B6	-.082	.106	.034	.459
B11	.206	-.141	.189	.422
B13	.293	.071	.108	.320

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 40 iterations.

F.4 Post-PCMS Behaviours towards Consumption and the Environment

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.848
Bartlett's Test of Sphericity	Approx. Chi-Square	577.617
	Df	15
	Sig.	.000

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.680	61.330	61.330	3.328	55.463	55.463
2	.942	15.697	77.026			
3	.527	8.788	85.814			
4	.439	7.322	93.136			
5	.230	3.840	96.976			
6	.181	3.024	100.000			

Extraction Method: Principal Axis Factoring.

Factor Matrix[a]

	Factor
	1
B16	.883
B19	.869
B17	.855
B15	.726
B20	.656
B18	.324

Extraction Method:
Principal Axis
Factoring.

a. 1 factors extracted.
5 iterations required.

F.5 Pre-PCMS PCTS Attitudes

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.769
Bartlett's Test of Sphericity	Approx. Chi-Square	365.990
	Df	10
	Sig.	.000

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.398	47.953	47.953	1.766	35.327	35.327
2	.864	17.271	65.224			
3	.649	12.970	78.195			
4	.590	11.792	89.986			
5	.501	10.014	100.000			

Extraction Method: Principal Axis Factoring.

Factor Matrix[a]

	Factor
	1
E1	.670
E10	.670
E6	.579
E2	.532

E5	.500

Extraction Method: Principal Axis Factoring.

a. 1 factors extracted. 6 iterations required.

Appendix G Pre-PCMS Model

This appendix contains the outputs of the *pre-PCMS model* regression analysis and assumption testing that was discussed in Section 5.4.1.

G.1 Regression Analysis

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	C1, A12, A9, A10[b]	.	Enter
2	B11, B8, B3, B12, B9[b]	.	Enter
3	B17, B15, B19, B16, B14, B18[b]	.	Enter
4	B4, B6, B2[b]	.	Enter
5	B13, B1, B5, B7[b]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. All requested variables entered.

Model Summary[f]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.227[a]	.052	.040	.81885894	.052	4.334	4	318	.002	
2	.405[b]	.164	.140	.77484926	.113	8.430	5	313	.000	
3	.427[c]	.183	.143	.77372257	.018	1.152	6	307	.332	
4	.500[d]	.250	.205	.74504285	.067	9.030	3	304	.000	
5	.630[e]	.397	.353	.67235386	.147	18.321	4	300	.000	1.828

a. Predictors: (Constant), C1, A12, A9, A10

b. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9

c. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18

d. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18, B4, B6, B2

e. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18, B4, B6, B2, B13, B1, B5, B7

f. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	11.624	4	2.906	4.334	.002[b]
1	Residual	213.229	318	.671		
	Total	224.853	322			
	Regression	36.930	9	4.103	6.834	.000[c]
2	Residual	187.923	313	.600		
	Total	224.853	322			
	Regression	41.068	15	2.738	4.573	.000[d]
3	Residual	183.785	307	.599		
	Total	224.853	322			
	Regression	56.105	18	3.117	5.615	.000[e]
4	Residual	168.747	304	.555		
	Total	224.853	322			
	Regression	89.235	22	4.056	8.973	.000[f]
5	Residual	135.618	300	.452		
	Total	224.853	322			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Predictors: (Constant), C1, A12, A9, A10

c. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9

d. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18

e. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18, B4, B6, B2

f. Predictors: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18, B4, B6, B2, B13, B1, B5, B7

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	-.191	.379		-.504	.615	-.936	.554
	A9	-.073	.057	-.073	-1.279	.202	-.184	.039
	A10	.065	.076	.052	.846	.398	-.086	.215
	A12	-.041	.073	-.034	-.560	.576	-.184	.102
	C1	.120	.037	.185	3.274	.001	.048	.193
2	(Constant)	-.901	.380		-2.374	.018	-1.648	-.154
	A9	-.008	.056	-.008	-.148	.883	-.118	.102
	A10	.026	.078	.021	.327	.744	-.129	.180
	A12	-.062	.070	-.051	-.882	.379	-.199	.076
	C1	.105	.035	.161	2.973	.003	.035	.174
	B3	.029	.039	.044	.741	.459	-.048	.107
	B8	.102	.047	.139	2.174	.030	.010	.194
	B9	.120	.048	.172	2.504	.013	.026	.215
	B11	.091	.049	.113	1.837	.067	-.006	.188
	B12	-.011	.031	-.023	-.349	.727	-.071	.050
3	(Constant)	-.798	.498		-1.602	.110	-1.779	.182
	A9	-.011	.056	-.011	-.196	.845	-.122	.100
	A10	.042	.079	.034	.529	.597	-.114	.198
	A12	-.052	.071	-.043	-.732	.465	-.190	.087
	C1	.102	.036	.157	2.857	.005	.032	.173
	B3	.035	.040	.052	.863	.389	-.044	.113
	B8	.104	.048	.141	2.170	.031	.010	.198
	B9	.120	.049	.171	2.474	.014	.025	.216
	B11	.094	.050	.117	1.876	.062	-.005	.192
	B12	-.015	.031	-.032	-.484	.629	-.076	.046
	B14	.021	.039	.035	.547	.585	-.056	.098
	B15	.002	.051	.003	.049	.961	-.097	.102

	B16	-.017	.041	-.030	-.430	.668	-.098	.063
	B17	-.066	.029	-.130	-2.239	.026	-.123	-.008
	B18	.041	.044	.070	.928	.354	-.046	.128
	B19	-.036	.035	-.064	-1.044	.297	-.104	.032
4	(Constant)	-1.406	.506		-2.780	.006	-2.402	-.411
	A9	-.029	.054	-.030	-.539	.590	-.137	.078
	A10	.054	.076	.044	.712	.477	-.096	.205
	A12	-.046	.068	-.038	-.680	.497	-.180	.087
	C1	.123	.035	.189	3.532	.000	.054	.191
	B3	.028	.039	.042	.721	.471	-.048	.105
	B8	.114	.046	.156	2.486	.013	.024	.205
	B9	.082	.047	.117	1.730	.085	-.011	.175
	B11	.080	.049	.100	1.645	.101	-.016	.176
	B12	-.024	.030	-.050	-.785	.433	-.083	.036
	B14	.006	.038	.010	.156	.876	-.069	.081
	B15	.044	.050	.061	.894	.372	-.053	.142
	B16	-.023	.039	-.040	-.586	.558	-.101	.055
	B17	-.044	.029	-.088	-1.548	.123	-.100	.012
	B18	.038	.043	.065	.885	.377	-.047	.123
	B19	-.038	.034	-.068	-1.133	.258	-.105	.028
	B2	.018	.029	.035	.625	.533	-.039	.075
	B4	-.009	.029	-.017	-.312	.755	-.067	.049
	B6	.140	.028	.270	4.933	.000	.084	.195
5	(Constant)	-1.651	.470		-3.514	.001	-2.576	-.727
	A9	-.067	.050	-.067	-1.344	.180	-.165	.031
	A10	.057	.069	.045	.817	.415	-.080	.193
	A12	-.050	.061	-.041	-.809	.419	-.170	.071
	C1	.090	.032	.138	2.838	.005	.028	.152
	B3	.014	.035	.021	.401	.689	-.055	.083
	B8	.061	.043	.083	1.418	.157	-.023	.145
	B9	.020	.045	.029	.447	.655	-.068	.108
	B11	.002	.047	.003	.053	.958	-.089	.094

B12	-.034	.027	-.071	-1.230	.220	-.088	.020
B14	.010	.035	.016	.283	.777	-.058	.078
B15	.038	.046	.052	.827	.409	-.052	.127
B16	-.038	.036	-.064	-1.042	.298	-.108	.033
B17	-.034	.026	-.068	-1.328	.185	-.085	.017
B18	.047	.039	.080	1.201	.231	-.030	.124
B19	-.016	.031	-.028	-.514	.607	-.077	.045
B2	.003	.026	.005	.099	.922	-.049	.054
B4	.003	.027	.006	.128	.898	-.050	.056
B6	.111	.027	.215	4.115	.000	.058	.164
B1	.091	.040	.137	2.267	.024	.012	.169
B5	.086	.045	.124	1.924	.055	-.002	.174
B7	.033	.045	.049	.745	.457	-.055	.121
B13	.155	.033	.273	4.716	.000	.090	.220

a. Dependent Variable: REGR factor score 1 for analysis 1

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
	B3	.169[b]	3.095	.002	.171	.971
	B8	.269[b]	4.958	.000	.268	.946
	B9	.303[b]	5.468	.000	.294	.892
	B11	.231[b]	4.319	.000	.236	.984
1	B12	.119[b]	1.876	.062	.105	.736
	B14	-.055[b]	-1.001	.318	-.056	.999
	B15	-.028[b]	-.512	.609	-.029	.990
	B16	-.022[b]	-.394	.694	-.022	.973
	B17	-.130[b]	-2.377	.018	-.132	.984

	B18	-.091[b]	-1.641	.102	-.092	.964
	B19	-.118[b]	-2.143	.033	-.120	.979
	B2	.080[b]	1.472	.142	.082	.998
	B4	.049[b]	.889	.375	.050	.991
	B6	.329[b]	6.330	.000	.335	.984
	B1	.355[b]	6.894	.000	.361	.982
	B5	.433[b]	8.722	.000	.440	.977
	B7	.421[b]	8.520	.000	.432	.995
	B13	.469[b]	9.585	.000	.474	.970
	B14	.003[c]	.062	.951	.004	.948
	B15	-.007[c]	-.126	.900	-.007	.978
	B16	-.019[c]	-.352	.725	-.020	.957
	B17	-.117[c]	-2.247	.025	-.126	.979
	B18	-.017[c]	-.304	.762	-.017	.900
	B19	-.066[c]	-1.243	.215	-.070	.947
2	B2	.074[c]	1.422	.156	.080	.974
	B4	.060[c]	1.137	.256	.064	.973
	B6	.279[c]	5.441	.000	.294	.929
	B1	.275[c]	4.913	.000	.268	.792
	B5	.354[c]	6.416	.000	.341	.776
	B7	.346[c]	5.908	.000	.317	.702
	B13	.415[c]	7.889	.000	.408	.807
	B2	.081[d]	1.518	.130	.086	.939
	B4	.054[d]	1.022	.308	.058	.950
	B6	.273[d]	5.179	.000	.284	.881
3	B1	.276[d]	4.792	.000	.264	.747
	B5	.349[d]	6.261	.000	.337	.761
	B7	.335[d]	5.687	.000	.309	.694
	B13	.416[d]	7.820	.000	.408	.789
4	B1	.296[e]	5.360	.000	.294	.740
	B5	.320[e]	5.810	.000	.317	.734

B7	.273[e]	4.546	.000	.253	.643
B13	.380[e]	7.260	.000	.385	.769

a. Dependent Variable: REGR factor score 1 for analysis 1

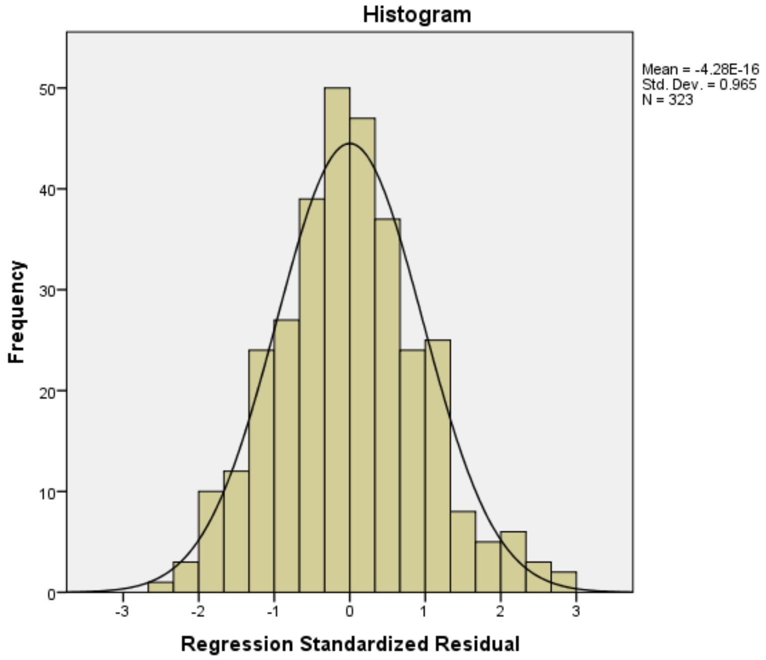
b. Predictors in the Model: (Constant), C1, A12, A9, A10

c. Predictors in the Model: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9

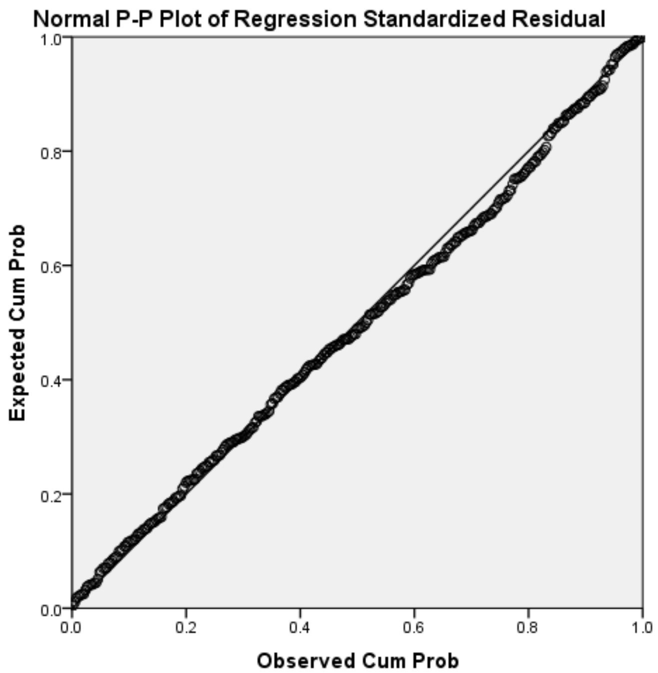
d. Predictors in the Model: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18

e. Predictors in the Model: (Constant), C1, A12, A9, A10, B11, B8, B3, B12, B9, B17, B15, B19, B16, B14, B18, B4, B6, B2

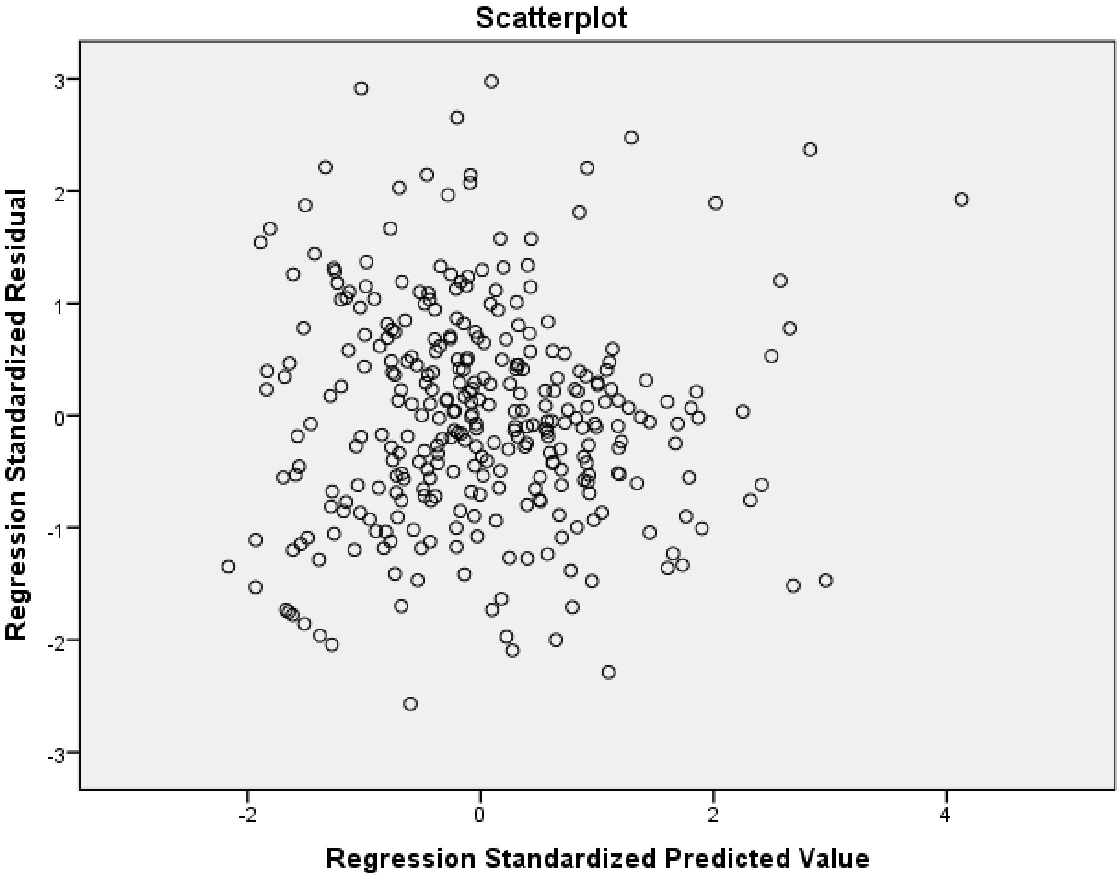
G.2 Charts



Histogram
Mean = -4.28E-16
Std. Dev. = 0.965
N = 323
Frequency
50
40
30
20
10
0
-3
-2
-1
0
1
2
3
Regression Standardized Residual



Normal P-P Plot of Regression Standardized Residual
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-3
-2
0
2
4

Appendix H First Post-PCMS Model

This appendix contains the outputs of the *first post-PCMS model* regression analysis and assumption testing that was discussed in Section 5.4.1.

H.1 Regression Analysis

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	B20, B18, B15, B17, B19, B16[b]	.	Enter
2	B5, B8, B1[b]	.	Enter
3	B4, B2[b]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. All requested variables entered.

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.379[a]	.143	.098	.68136217	.143	3.179	6	114	.006	
2	.636[b]	.404	.356	.57599029	.261	16.175	3	111	.000	
3	.639[c]	.408	.348	.57926579	.004	.374	2	109	.689	2.056

a. Predictors: (Constant), B20, B18, B15, B17, B19, B16

b. Predictors: (Constant), B20, B18, B15, B17, B19, B16, B5, B8, B1

c. Predictors: (Constant), B20, B18, B15, B17, B19, B16, B5, B8, B1, B4, B2

d. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a]

Model	Sum of Squares	Df	Mean Square	F	Sig.

	Regression	8.854	6	1.476	3.179	.006[b]
1	Residual	52.925	114	.464		
	Total	61.779	120			
	Regression	24.953	9	2.773	8.357	.000[c]
2	Residual	36.826	111	.332		
	Total	61.779	120			
	Regression	25.204	11	2.291	6.829	.000[d]
3	Residual	36.575	109	.336		
	Total	61.779	120			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Predictors: (Constant), B20, B18, B15, B17, B19, B16

c. Predictors: (Constant), B20, B18, B15, B17, B19, B16, B5, B8, B1

d. Predictors: (Constant), B20, B18, B15, B17, B19, B16, B5, B8, B1, B4, B2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.883	.266		3.321	.001	.356	1.409
	B15	.007	.047	.020	.153	.879	-.085	.100
	B16	-.087	.068	-.219	-1.276	.205	-.222	.048
	B17	-.010	.062	-.028	-.166	.868	-.134	.113
	B18	-.047	.042	-.106	-1.117	.266	-.130	.036
	B19	-.075	.068	-.173	-1.103	.272	-.210	.060
	B20	.035	.049	.078	.714	.477	-.061	.131
2	(Constant)	-.606	.315		-1.923	.057	-1.229	.018
	B15	-.040	.041	-.109	-.963	.337	-.121	.042
	B16	-.094	.058	-.237	-1.628	.106	-.208	.020
	B17	.108	.059	.293	1.819	.072	-.010	.225
	B18	-.041	.036	-.093	-1.149	.253	-.112	.030
	B19	-.079	.059	-.182	-1.344	.182	-.196	.038

	B20	.078	.042	.176	1.867	.065	-.005	.162
	B1	.207	.057	.376	3.612	.000	.093	.320
	B5	.194	.060	.296	3.251	.002	.076	.312
	B8	.002	.068	.002	.025	.980	-.132	.136
	(Constant)	-.635	.340		-1.868	.064	-1.308	.039
	B15	-.036	.042	-.098	-.860	.391	-.118	.047
	B16	-.100	.059	-.253	-1.705	.091	-.217	.016
	B17	.109	.060	.297	1.832	.070	-.009	.227
	B18	-.044	.036	-.100	-1.215	.227	-.116	.028
	B19	-.083	.060	-.191	-1.398	.165	-.201	.035
3	B20	.082	.043	.183	1.918	.058	-.003	.166
	B1	.209	.058	.379	3.609	.000	.094	.323
	B5	.196	.061	.299	3.235	.002	.076	.316
	B8	-.001	.068	-.002	-.018	.985	-.136	.134
	B2	-.020	.037	-.048	-.555	.580	-.093	.052
	B4	.030	.035	.072	.845	.400	-.040	.099

a. Dependent Variable: REGR factor score 1 for analysis 1

Excluded Variables[a]

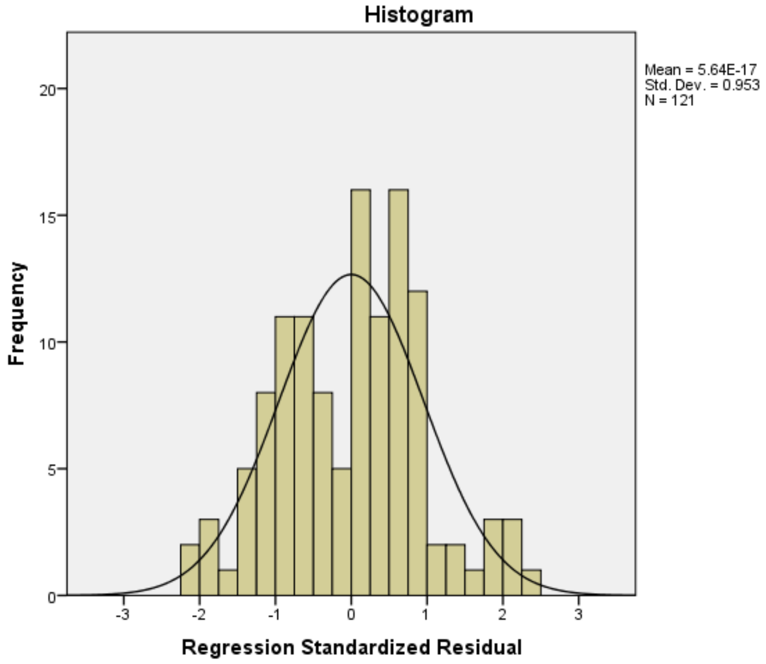
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	B1	.520[b]	5.912	.000	.486	.750
	B5	.459[b]	5.411	.000	.454	.837
	B8	.302[b]	3.063	.003	.277	.718
	B2	.091[b]	1.027	.307	.096	.959
	B4	.097[b]	1.107	.271	.104	.976
2	B2	-.014[c]	-.184	.855	-.018	.918
	B4	.050[c]	.665	.507	.063	.966

a. Dependent Variable: REGR factor score 1 for analysis 1

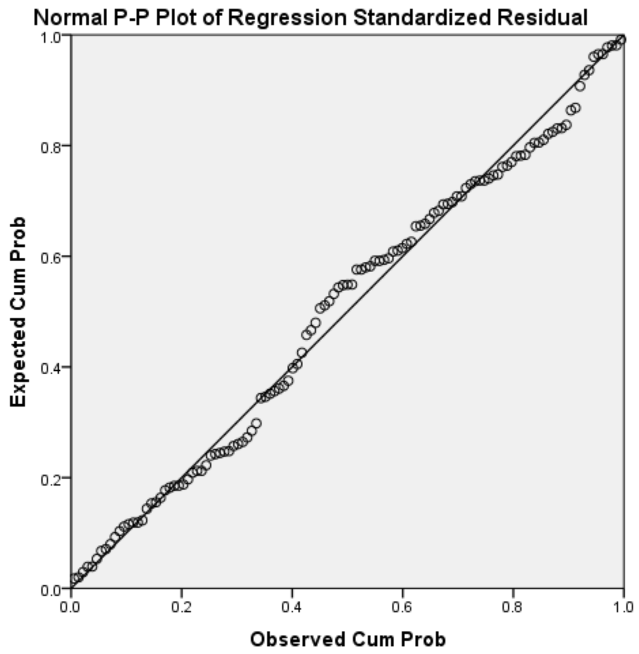
b. Predictors in the Model: (Constant), B20, B18, B15, B17, B19, B16

c. Predictors in the Model: (Constant), B20, B18, B15, B17, B19, B16, B5, B8, B1

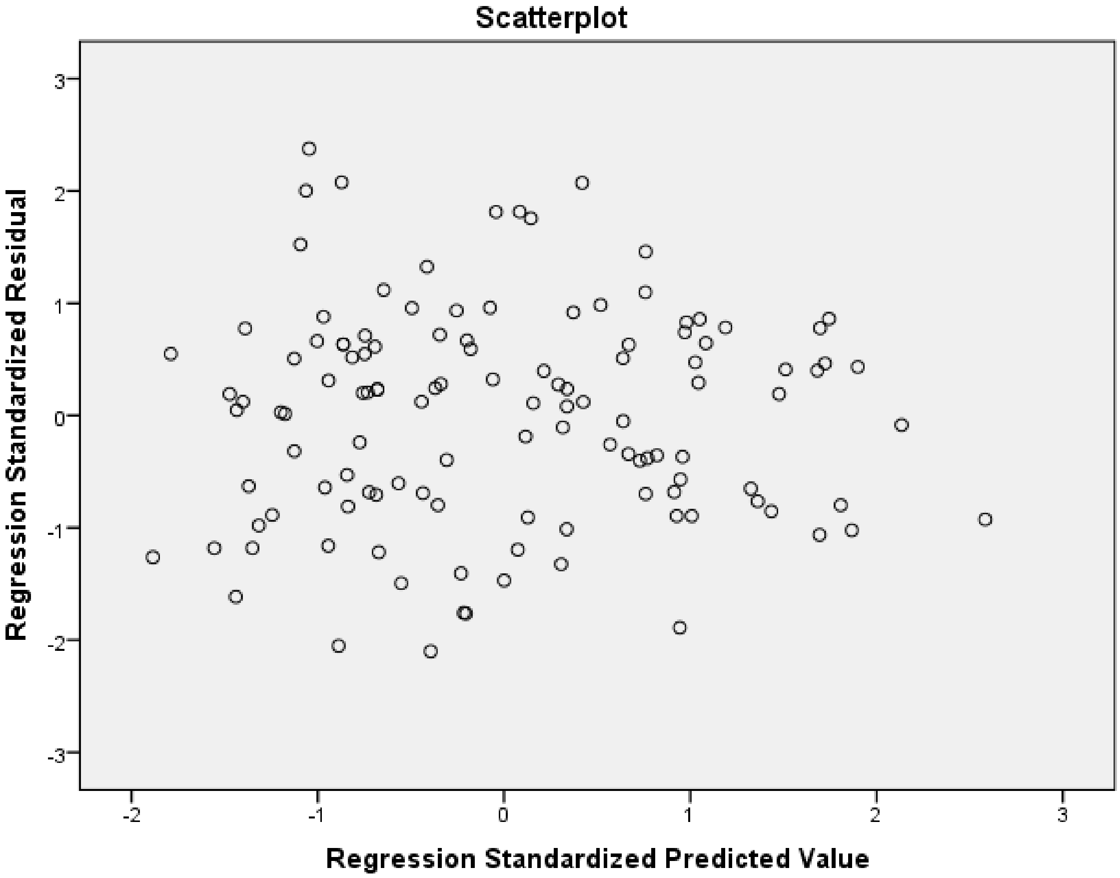
H.2 Charts



Histogram
Mean = 5.64E-17
Std. Dev. = 0.953
N = 121
Frequency
Regression Standardized Residual



Normal P-P Plot of Regression Standardized Residual
Expected Cum Prob
Observed Cum Prob



Scatterplot
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-3
-2
-1
0
1
2
3

Appendix I Second Post-PCMS Model

This appendix contains the outputs of the *second post-PCMS model* regression analysis and assumption testing that was discussed in Section 5.4.1.

I.1 Regression Analysis

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	B12, B9[b]	.	Enter
2	B6, B11, B13, B7[b]	.	Enter
3	C1, A11, A8, A9[b]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. All requested variables entered.

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.444[a]	.197	.183	.68184338	.197	13.840	2	113	.000	
2	.601[b]	.361	.326	.61926493	.164	6.998	4	109	.000	
3	.642[c]	.412	.356	.60522806	.051	2.279	4	105	.066	2.163

a. Predictors: (Constant), B12, B9

b. Predictors: (Constant), B12, B9, B6, B11, B13, B7

c. Predictors: (Constant), B12, B9, B6, B11, B13, B7, C1, A11, A8, A9

d. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a]

Model	Sum of Squares	Df	Mean Square	F	Sig.

	Regression	12.868	2	6.434	13.840	.000[b]
1	Residual	52.535	113	.465		
	Total	65.403	115			
	Regression	23.603	6	3.934	10.258	.000[c]
2	Residual	41.800	109	.383		
	Total	65.403	115			
	Regression	26.942	10	2.694	7.355	.000[d]
3	Residual	38.462	105	.366		
	Total	65.403	115			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Predictors: (Constant), B12, B9

c. Predictors: (Constant), B12, B9, B6, B11, B13, B7

d. Predictors: (Constant), B12, B9, B6, B11, B13, B7, C1, A11, A8, A9

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
	(Constant)	-.724	.138		-5.252	.000	-.997	-.451
1	B9	.205	.057	.341	3.563	.001	.091	.319
	B12	.067	.039	.165	1.724	.087	-.010	.143
	(Constant)	-1.171	.172		-6.826	.000	-1.511	-.831
	B9	.065	.059	.108	1.101	.273	-.052	.181
	B12	.043	.036	.107	1.194	.235	-.029	.115
2	B6	.033	.035	.075	.945	.347	-.036	.101
	B7	.048	.069	.068	.694	.489	-.089	.185
	B11	.188	.068	.257	2.783	.006	.054	.322
	B13	.142	.049	.269	2.914	.004	.045	.239
	(Constant)	.242	.594		.407	.685	-.936	1.419
3	B9	.070	.061	.117	1.151	.252	-.051	.192
	B12	.035	.039	.087	.911	.365	-.041	.112

B6	.046	.034	.105	1.329	.187	-.022	.114
B7	.049	.069	.069	.709	.480	-.087	.185
B11	.164	.069	.225	2.376	.019	.027	.301
B13	.132	.049	.250	2.691	.008	.035	.230
A8	-.137	.075	-.155	-1.821	.071	-.287	.012
A9	-.047	.112	-.037	-.422	.674	-.270	.175
A11	-.142	.096	-.124	-1.470	.144	-.333	.049
C1	-.077	.051	-.124	-1.520	.132	-.178	.023

a. Dependent Variable: REGR factor score 1 for analysis 1

Excluded Variables[a]

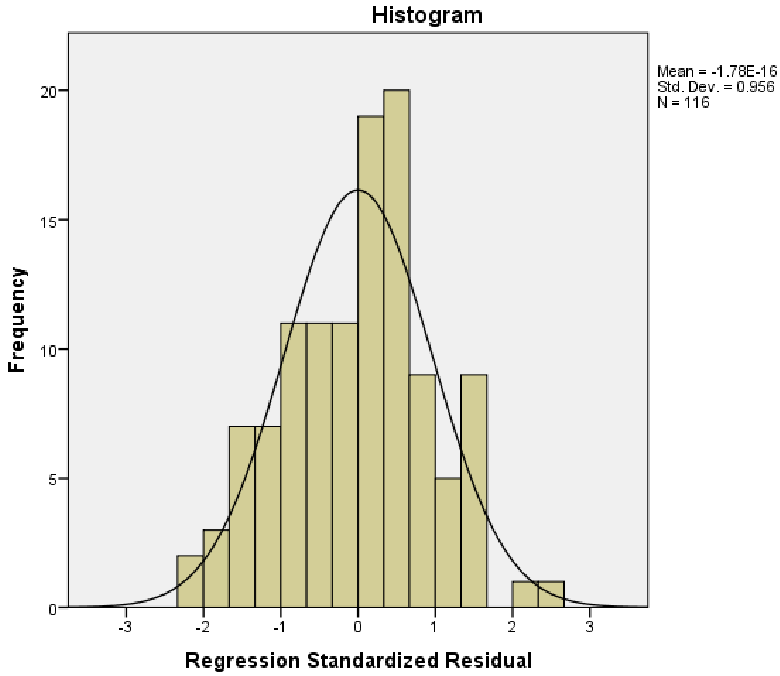
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	B6	.117[b]	1.360	.176	.128	.961
	B7	.277[b]	3.112	.002	.282	.833
	B11	.331[b]	3.795	.000	.338	.837
	B13	.331[b]	3.629	.000	.324	.771
	A8	-.156[b]	-1.734	.086	-.162	.864
	A9	-.104[b]	-1.146	.254	-.108	.853
	A11	-.215[b]	-2.497	.014	-.230	.919
	C1	-.105[b]	-1.236	.219	-.116	.975
2	A8	-.170[c]	-2.061	.042	-.195	.837
	A9	-.022[c]	-.255	.799	-.025	.783
	A11	-.108[c]	-1.303	.195	-.124	.846
	C1	-.150[c]	-1.888	.062	-.179	.912

a. Dependent Variable: REGR factor score 1 for analysis 1

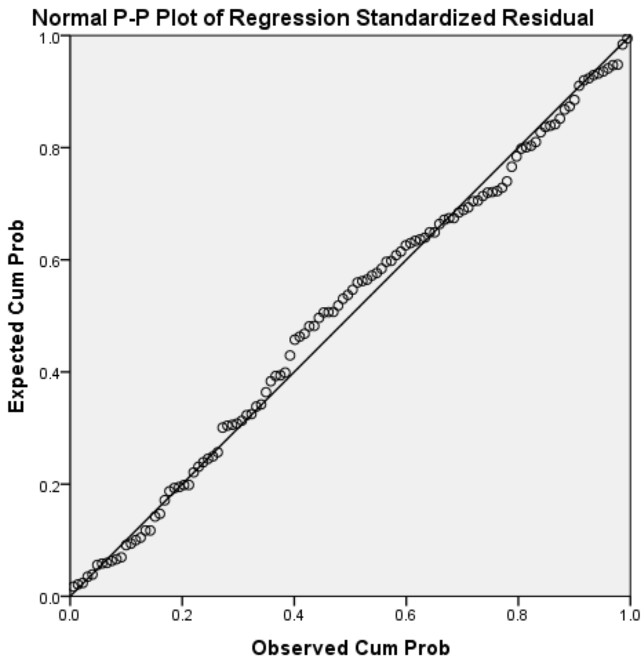
b. Predictors in the Model: (Constant), B12, B9

c. Predictors in the Model: (Constant), B12, B9, B6, B11, B13, B7

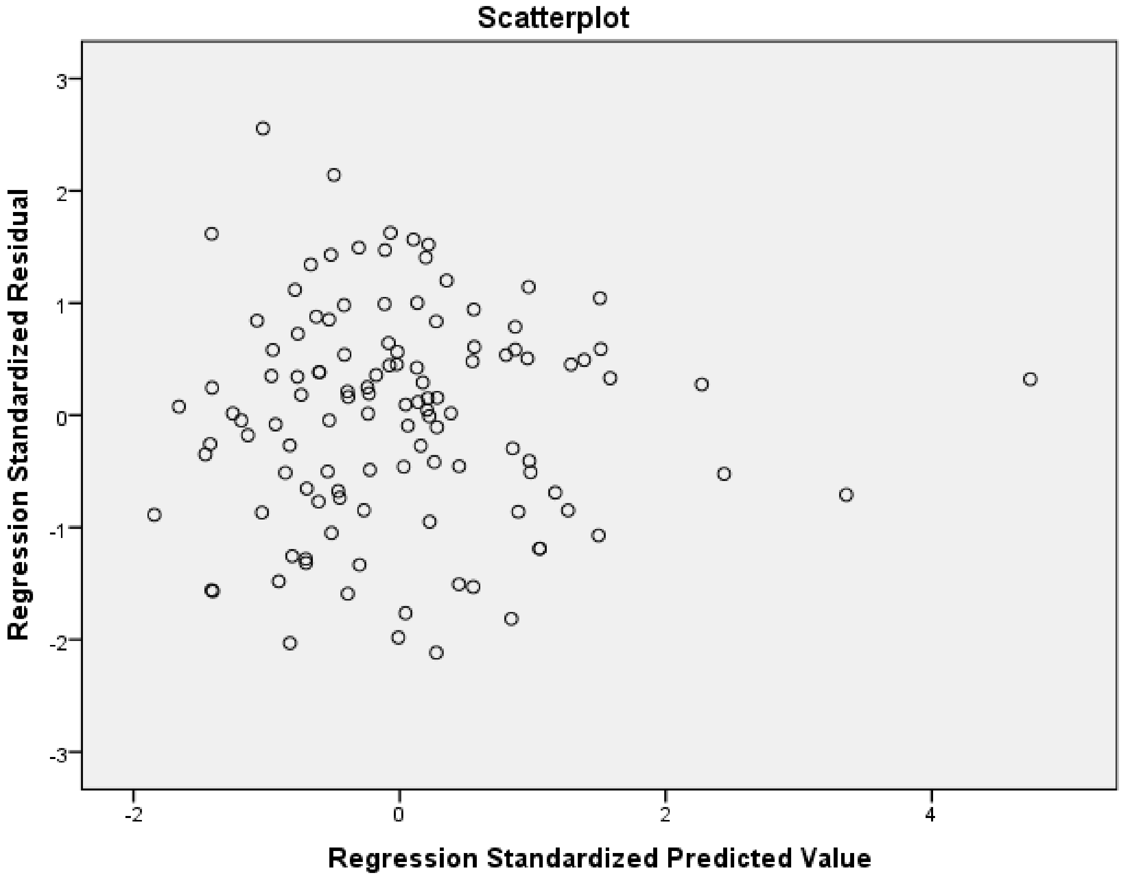
I.2 Charts



Histogram
Mean = -1.78E-16
Std. Dev. = 0.956
N = 116
Frequency
20
15
10
5
0
-3
-2
-1
0
1
2
3
Regression Standardized Residual



Normal P-P Plot of Regression Standardized Residual
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-3
-2
0
2
4

Appendix J First Post-PCMS Model for PCMS users

This appendix contains the outputs of the *first post-PCMS model for PCMS users* regression analysis and assumption testing that was discussed in Section 5.4.2.

J.1 Regression Analysis

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	B20, B15, B18, B17, B16, B19[c]	.	Enter
2	B5, B1, B8[c]	.	Enter
3	B4, B2[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 1

c. All requested variables entered.

Model Summary[d,e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 1 (Selected)				R Square Change	F Change	df1	df2	Sig. F Change	F10 = 1 (Selected)
1	.387[a]	.150	.074	.66680596	.150	1.970	6	67	.082	
2	.645[b]	.416	.334	.56546686	.266	9.722	3	64	.000	
3	.654[c]	.428	.326	.56867303	.012	.640	2	62	.531	2.262

a. Predictors: (Constant), B20, B15, B18, B17, B16, B19

b. Predictors: (Constant), B20, B15, B18, B17, B16, B19, B5, B1, B8

c. Predictors: (Constant), B20, B15, B18, B17, B16, B19, B5, B1, B8, B4, B2

d. Unless noted otherwise, statistics are based only on cases for which F10 = 1.

e. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.255	6	.876	1.970	.082[c]
	Residual	29.790	67	.445		
	Total	35.045	73			
2	Regression	14.581	9	1.620	5.067	.000[d]
	Residual	20.464	64	.320		
	Total	35.045	73			
3	Regression	14.995	11	1.363	4.215	.000[e]
	Residual	20.050	62	.323		
	Total	35.045	73			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

c. Predictors: (Constant), B20, B15, B18, B17, B16, B19

d. Predictors: (Constant), B20, B15, B18, B17, B16, B19, B5, B1, B8

e. Predictors: (Constant), B20, B15, B18, B17, B16, B19, B5, B1, B8, B4, B2

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.604	.358		1.685	.097	-.111	1.319
	B15	.051	.057	.140	.895	.374	-.063	.165
	B16	-.147	.082	-.362	-1.795	.077	-.311	.016
	B17	-.079	.075	-.224	-1.050	.297	-.230	.071
	B18	-.044	.055	-.102	-.795	.430	-.154	.066
	B19	.047	.098	.104	.474	.637	-.150	.243
	B20	.026	.068	.057	.380	.705	-.109	.161

2	(Constant)	-.834	.433		-1.925	.059	-1.700	.031
	B15	.011	.051	.030	.214	.831	-.090	.112
	B16	-.125	.071	-.306	-1.763	.083	-.266	.017
	B17	.012	.079	.033	.147	.884	-.146	.169
	B18	-.044	.047	-.101	-.931	.355	-.137	.050
	B19	.013	.086	.030	.155	.877	-.159	.186
	B20	.096	.063	.212	1.539	.129	-.029	.221
	B1	.240	.075	.458	3.194	.002	.090	.390
	B5	.165	.076	.251	2.156	.035	.012	.317
	B8	-.029	.096	-.046	-.301	.764	-.220	.163
3	(Constant)	-.922	.448		-2.057	.044	-1.818	-.026
	B15	.020	.052	.054	.387	.700	-.083	.123
	B16	-.134	.072	-.329	-1.869	.066	-.278	.009
	B17	.002	.080	.005	.022	.982	-.158	.161
	B18	-.056	.048	-.130	-1.155	.253	-.153	.041
	B19	.015	.087	.034	.176	.861	-.158	.189
	B20	.101	.065	.224	1.572	.121	-.028	.231
	B1	.244	.077	.465	3.157	.002	.089	.398
	B5	.155	.079	.236	1.974	.053	-.002	.312
	B8	-.044	.099	-.070	-.448	.656	-.241	.153
	B2	-.001	.050	-.002	-.019	.985	-.102	.100
	B4	.047	.046	.117	1.021	.311	-.045	.140

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	B1	.554[b]	4.844	.000	.512	.727
	B5	.429[b]	3.809	.000	.424	.831

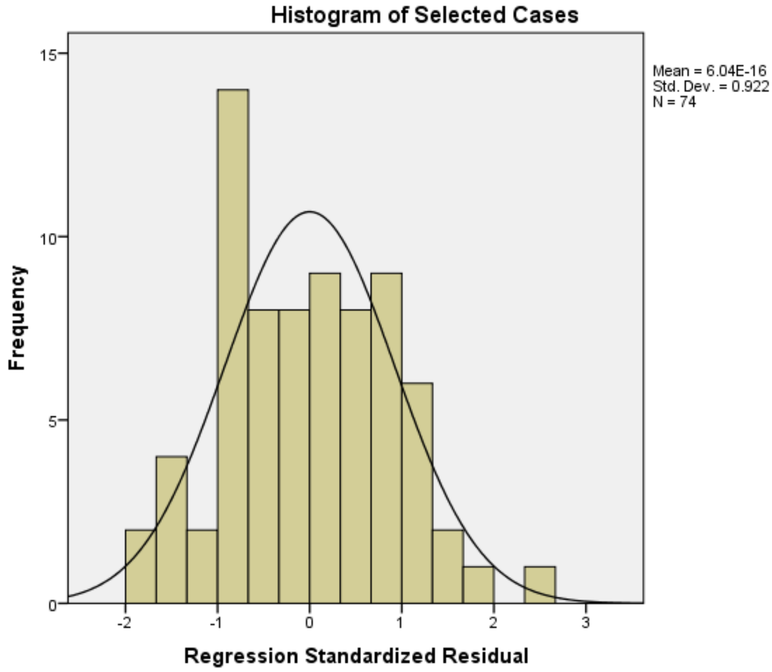
	B8	.310[b]	2.088	.041	.249	.549
	B2	.206[b]	1.843	.070	.221	.976
	B4	.175[b]	1.503	.138	.182	.918
2	B2	.050[c]	.488	.627	.061	.872
	B4	.116[c]	1.140	.258	.142	.883

a. Dependent Variable: REGR factor score 1 for analysis 1

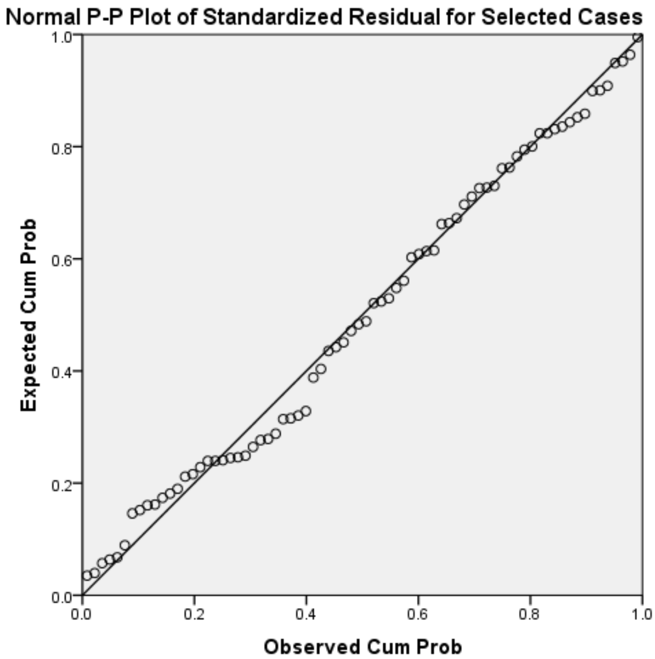
b. Predictors in the Model: (Constant), B20, B15, B18, B17, B16, B19

c. Predictors in the Model: (Constant), B20, B15, B18, B17, B16, B19, B5, B1, B8

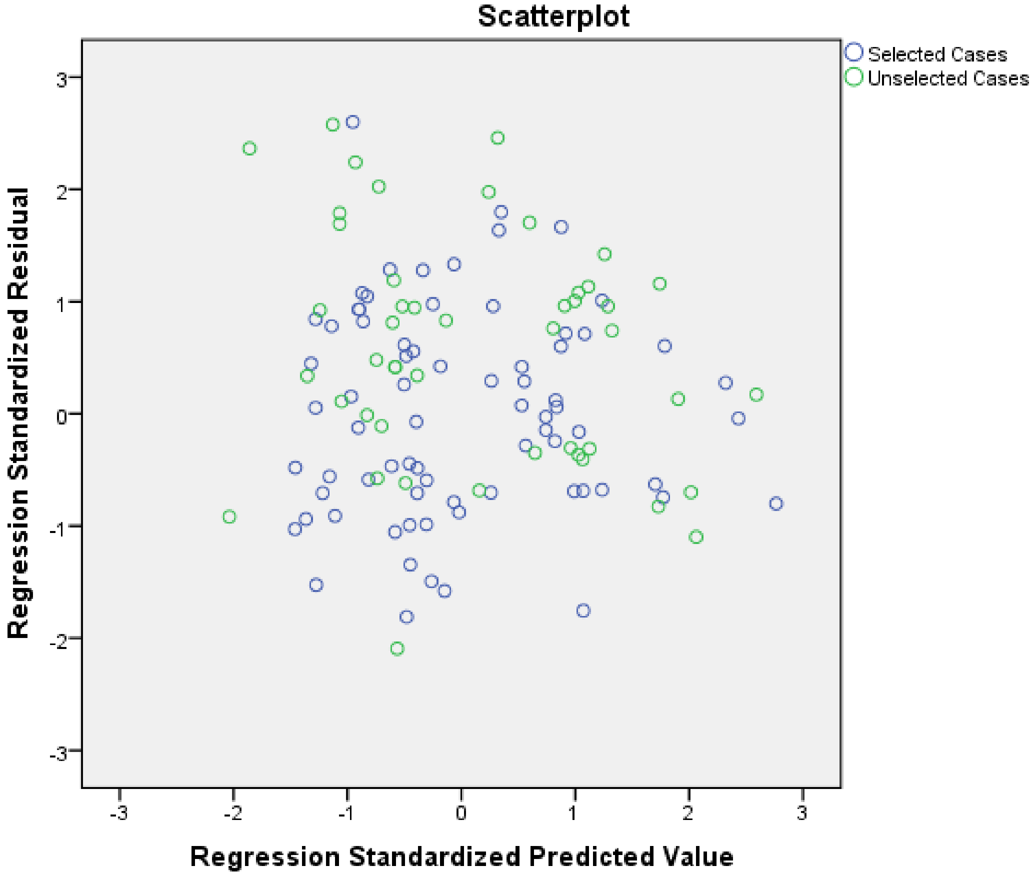
J.2 Charts



Histogram of Selected Cases
Mean = 6.04E-16
Std. Dev. = 0.922
N = 74
Frequency
15
10
5
0
-2
-1
0
1
2
3
Regression Standardized Residual



Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-3

Appendix K First Post-PCMS Model for non-PCMS users

This appendix contains the outputs of the *first post-PCMS model for non-PCMS users* regression analysis and assumption testing that was discussed in Section 5.4.2.

K.1 Regression Analysis

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	B20, B15, B18, B19, B17, B16[c]	.	Enter
2	B8, B5, B1[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 2

c. All requested variables entered.

Model Summary[c,d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 2 (Selected)				R Square Change	F Change	df1	df2	Sig. F Change	F10 = 2 (Selected)
1	.457[a]	.209	.069	.63309323	.209	1.498	6	34	.209	
2	.646[b]	.417	.248	.56910406	.208	3.692	3	31	.022	1.691

a. Predictors: (Constant), B20, B15, B18, B19, B17, B16

b. Predictors: (Constant), B20, B15, B18, B19, B17, B16, B8, B5, B1

c. Unless noted otherwise, statistics are based only on cases for which F10 = 2.

d. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	3.602	6	.600	1.498	.209[c]
1	Residual	13.627	34	.401		
	Total	17.230	40			
	Regression	7.189	9	.799	2.466	.030[d]
2	Residual	10.040	31	.324		
	Total	17.230	40			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 2

c. Predictors: (Constant), B20, B15, B18, B19, B17, B16

d. Predictors: (Constant), B20, B15, B18, B19, B17, B16, B8, B5, B1

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
	(Constant)	.927	.369		2.513	.017	.177	1.676
	B15	-.081	.082	-.270	-.985	.331	-.247	.086
	B16	.181	.159	.574	1.135	.264	-.143	.504
1	B17	-.177	.156	-.555	-1.130	.267	-.495	.141
	B18	.001	.071	.003	.018	.985	-.143	.146
	B19	-.086	.101	-.247	-.844	.405	-.291	.120
	B20	.018	.071	.049	.247	.806	-.128	.163
	(Constant)	-.412	.521		-.790	.436	-1.475	.652
	B15	-.121	.076	-.405	-1.593	.121	-.276	.034
	B16	-.045	.160	-.143	-.281	.780	-.372	.282
2	B17	.173	.181	.543	.953	.348	-.197	.543
	B18	.008	.066	.019	.119	.906	-.126	.142
	B19	-.121	.096	-.349	-1.259	.217	-.316	.075
	B20	.049	.065	.135	.748	.460	-.084	.182

B1	.201	.113	.392	1.774	.086	-.030	.433
B5	.167	.112	.287	1.494	.145	-.061	.395
B8	.019	.139	.025	.134	.894	-.265	.303

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 2

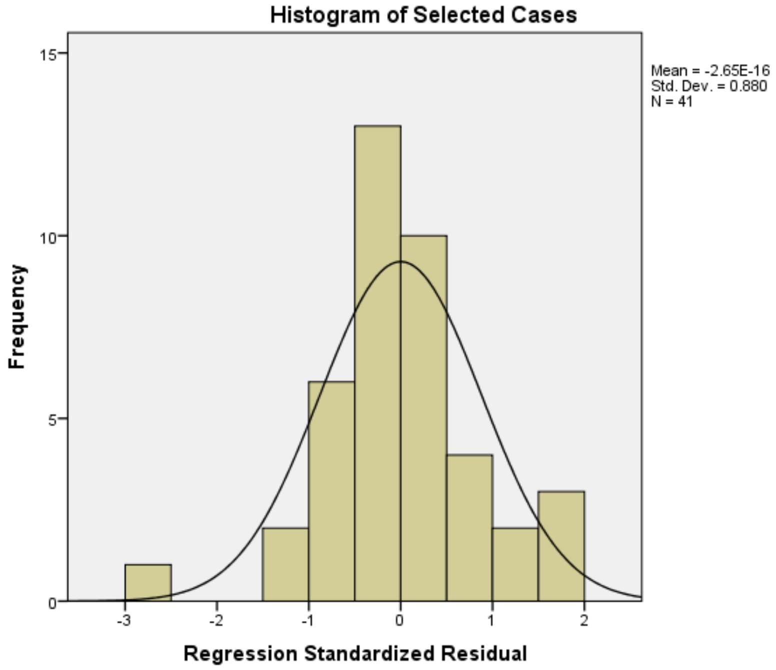
Excluded Variables[a]

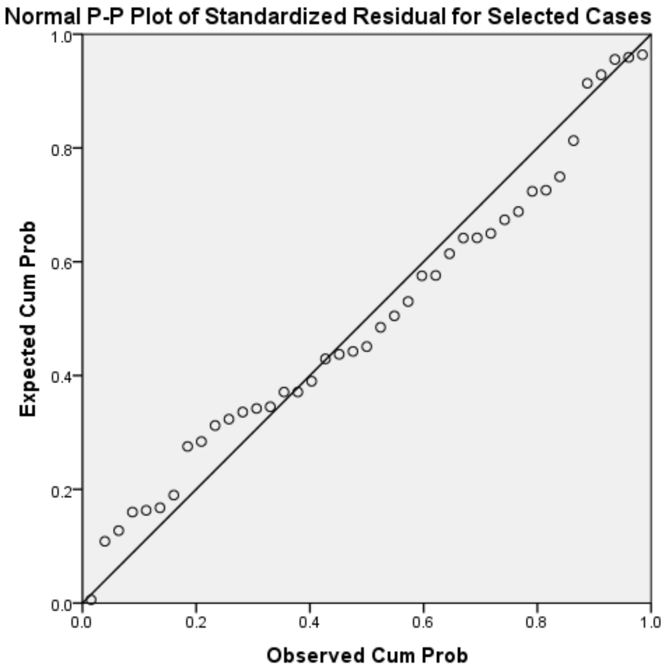
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
	B1	.547[b]	2.883	.007	.449	.531
1	B5	.447[b]	2.642	.013	.418	.690
	B8	.298[b]	1.739	.091	.290	.750

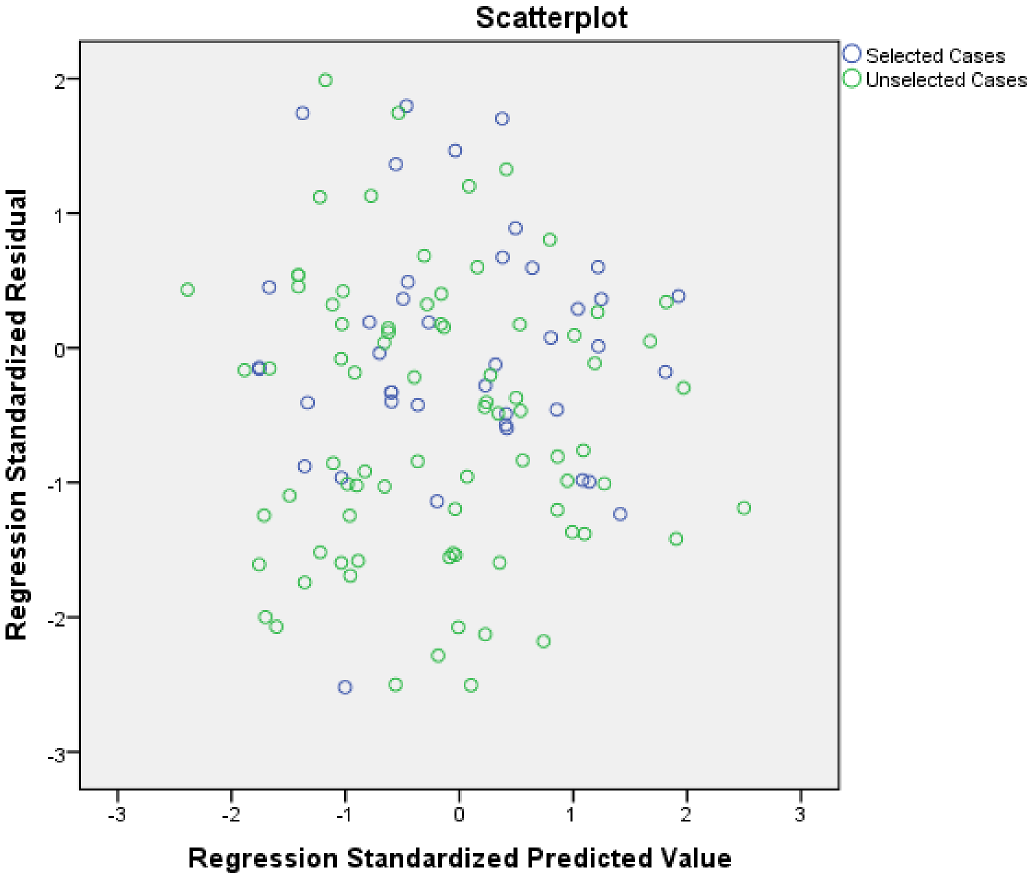
a. Dependent Variable: REGR factor score 1 for analysis 1

b. Predictors in the Model: (Constant), B20, B15, B18, B19, B17, B16

K.2 Charts


Histogram of Selected Cases
Mean = -2.65E-16
Std. Dev. = 0.880
N = 41
Frequency
Regression Standardized Residual
15
10
5
0
-3
-2
-1
0
1
2


Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
Observed Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0



Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
Regression Standardized Predicted Value
2
1
0
-1
-2
-3
-3
-2
-1
0
1
2
3

Appendix L Second Post-PCMS Model for PCMS users

This appendix contains the outputs of the *second post-PCMS model for PCMS users* regression analysis and assumption testing that was discussed in Section 5.4.2.

L.1 Regression Analysis

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	B12, B9[c]	.	Enter
2	B6, B13, B11, B7[c]	.	Enter
3	C1, A8, A11, A9[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 1

c. All requested variables entered.

Model Summary[d,e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 1 (Selected)				R Square Change	F Change	df1	df2	Sig. F Change	F10 = 1 (Selected)
1	.313[a]	.098	.071	.66948998	.098	3.643	2	67	.031	
2	.556[b]	.309	.243	.60435211	.211	4.805	4	63	.002	
3	.572[c]	.327	.213	.61634255	.018	.393	4	59	.813	2.089

a. Predictors: (Constant), B12, B9

b. Predictors: (Constant), B12, B9, B6, B13, B11, B7

c. Predictors: (Constant), B12, B9, B6, B13, B11, B7, C1, A8, A11, A9

d. Unless noted otherwise, statistics are based only on cases for which F10 = 1.

e. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.266	2	1.633	3.643	.031[c]
	Residual	30.031	67	.448		
	Total	33.296	69			
2	Regression	10.286	6	1.714	4.694	.001[d]
	Residual	23.010	63	.365		
	Total	33.296	69			
3	Regression	10.883	10	1.088	2.865	.006[e]
	Residual	22.413	59	.380		
	Total	33.296	69			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

c. Predictors: (Constant), B12, B9

d. Predictors: (Constant), B12, B9, B6, B13, B11, B7

e. Predictors: (Constant), B12, B9, B6, B13, B11, B7, C1, A8, A11, A9

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.740	.199		-3.712	.000	-1.138	-.342
	B9	.166	.090	.239	1.839	.070	-.014	.346
	B12	.052	.056	.121	.926	.358	-.060	.164
2	(Constant)	-1.508	.269		-5.614	.000	-2.045	-.971
	B9	.077	.088	.111	.874	.385	-.099	.253
	B12	.038	.054	.088	.708	.482	-.069	.146
	B6	.042	.047	.103	.893	.375	-.052	.135
	B7	.095	.095	.128	.996	.323	-.095	.285
	B11	.240	.132	.232	1.818	.074	-.024	.503
	B13	.153	.059	.297	2.603	.011	.036	.270

3	(Constant)	-.730	.950		-.769	.445	-2.631	1.171
	B9	.086	.096	.124	.896	.374	-.106	.279
	B12	.033	.062	.076	.533	.596	-.091	.156
	B6	.057	.050	.140	1.147	.256	-.042	.156
	B7	.087	.099	.117	.879	.383	-.111	.286
	B11	.212	.139	.205	1.526	.132	-.066	.489
	B13	.147	.062	.284	2.378	.021	.023	.270
	A8	-.074	.100	-.093	-.739	.463	-.275	.127
	A9	-.015	.173	-.012	-.089	.930	-.362	.331
	A11	-.080	.135	-.075	-.591	.557	-.350	.190
	C1	-.053	.073	-.088	-.720	.475	-.200	.094

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

Excluded Variables[a]

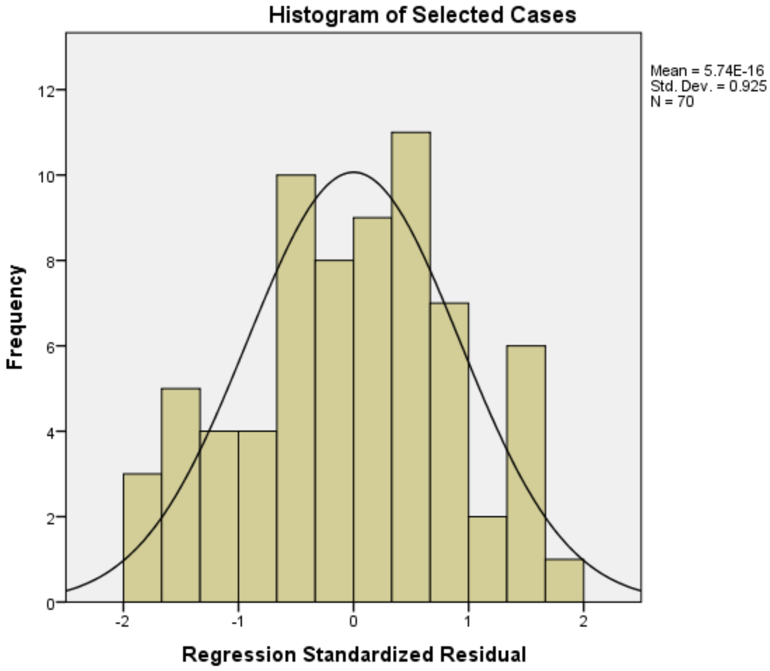
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	B6	.201[b]	1.710	.092	.206	.946
	B7	.331[b]	2.877	.005	.334	.918
	B11	.309[b]	2.572	.012	.302	.861
	B13	.324[b]	2.858	.006	.332	.945
	A8	-.115[b]	-.903	.370	-.110	.828
	A9	-.003[b]	-.025	.980	-.003	.786
	A11	-.149[b]	-1.125	.265	-.137	.766
	C1	-.091[b]	-.755	.453	-.093	.924
2	A8	-.101[c]	-.853	.397	-.108	.793
	A9	.029[c]	.235	.815	.030	.756
	A11	-.063[c]	-.507	.614	-.064	.726
	C1	-.100[c]	-.875	.385	-.110	.844

a. Dependent Variable: REGR factor score 1 for analysis 1

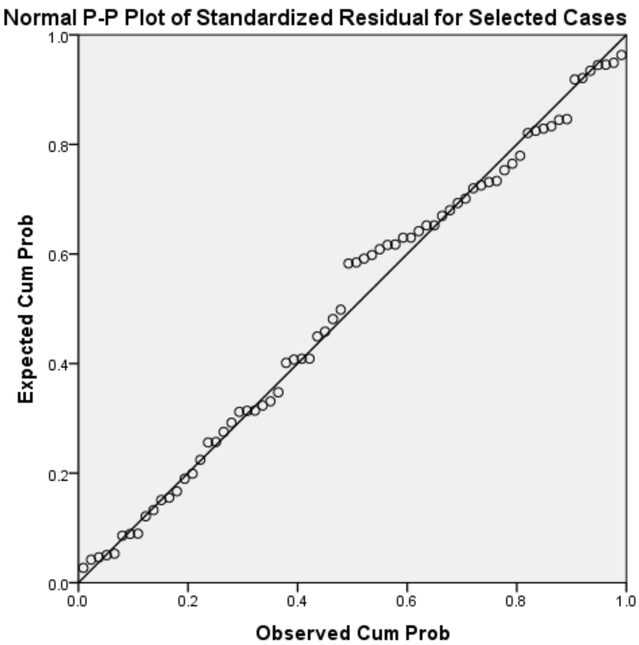
b. Predictors in the Model: (Constant), B12, B9

c. Predictors in the Model: (Constant), B12, B9, B6, B13, B11, B7

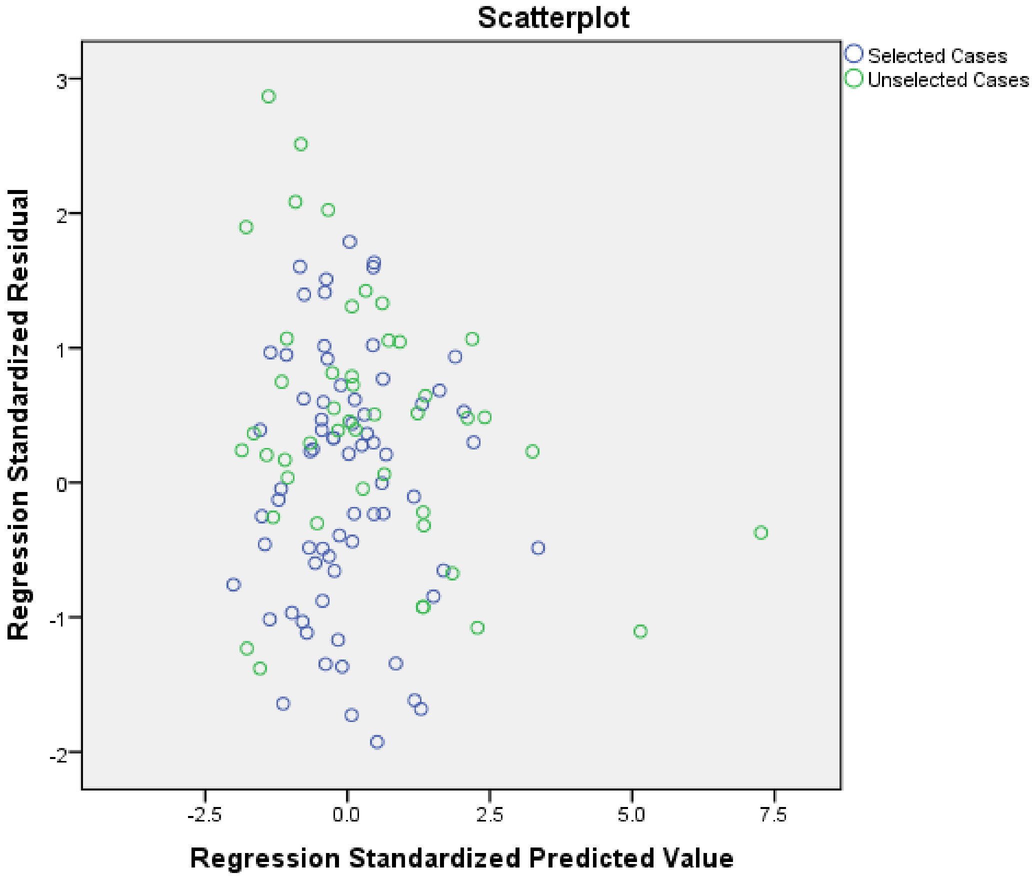
L.2 Charts



Histogram of Selected Cases
Mean = 5.74E-16
Std. Dev. = 0.925
N = 70
Frequency
Regression Standardized Residual



Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
Observed Cum Prob


Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
3
2
1
0
-1
-2
-2.5
0.0
2.5
5.0
7.5
Regression Standardized Predicted Value

Appendix M Second Post-PCMS Model for non-PCMS users

This appendix contains the outputs of the *second post-PCMS model for non-PCMS users* regression analysis and assumption testing that was discussed in Section 5.4.2.

M.1 Regression

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	B12, B9[c]	.	Enter
2	B6, B11, B7, B13[c]	.	Enter
3	C1, A11, A8, A9[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 2

c. All requested variables entered.

Model Summary[d,e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 2 (Selected)				R Square Change	F Change	df1	df2	Sig. F Change	F10 = 2 (Selected)
1	.539[a]	.291	.252	.64697647	.291	7.585	2	37	.002	
2	.654[b]	.428	.324	.61533660	.137	1.976	4	33	.121	
3	.797[c]	.636	.510	.52367244	.208	4.141	4	29	.009	1.812

a. Predictors: (Constant), B12, B9

b. Predictors: (Constant), B12, B9, B6, B11, B7, B13

c. Predictors: (Constant), B12, B9, B6, B11, B7, B13, C1, A11, A8, A9

d. Unless noted otherwise, statistics are based only on cases for which F10 = 2.

e. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.350	2	3.175	7.585	.002[c]
	Residual	15.487	37	.419		
	Total	21.838	39			
2	Regression	9.343	6	1.557	4.112	.003[d]
	Residual	12.495	33	.379		
	Total	21.838	39			
3	Regression	13.885	10	1.388	5.063	.000[e]
	Residual	7.953	29	.274		
	Total	21.838	39			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 2

c. Predictors: (Constant), B12, B9

d. Predictors: (Constant), B12, B9, B6, B11, B7, B13

e. Predictors: (Constant), B12, B9, B6, B11, B7, B13, C1, A11, A8, A9

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.451	.202		-2.237	.031	-.860	-.042
	B9	.208	.075	.444	2.789	.008	.057	.360
	B12	.052	.053	.156	.982	.332	-.055	.159
2	(Constant)	-.676	.262		-2.584	.014	-1.209	-.144
	B9	.092	.106	.196	.867	.392	-.124	.307
	B12	.036	.051	.109	.706	.485	-.068	.140
	B6	-.008	.058	-.018	-.133	.895	-.125	.110
	B7	.033	.107	.054	.310	.758	-.185	.251
	B11	.197	.092	.334	2.139	.040	.010	.384
	B13	.075	.117	.154	.635	.530	-.164	.313

	(Constant)	.851	.716		1.188	.244	-.614	2.316
	B9	.148	.096	.315	1.546	.133	-.048	.343
	B12	-.012	.050	-.036	-.239	.813	-.114	.090
	B6	-.023	.051	-.055	-.447	.658	-.127	.082
	B7	.083	.093	.136	.889	.382	-.108	.274
3	B11	.258	.089	.438	2.908	.007	.076	.439
	B13	-.002	.104	-.004	-.021	.984	-.215	.211
	A8	-.104	.116	-.118	-.900	.376	-.340	.132
	A9	.262	.163	.251	1.613	.118	-.070	.595
	A11	-.517	.152	-.457	-3.411	.002	-.827	-.207
	C1	-.107	.066	-.198	-1.627	.115	-.242	.028

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 2

Excluded Variables[a]

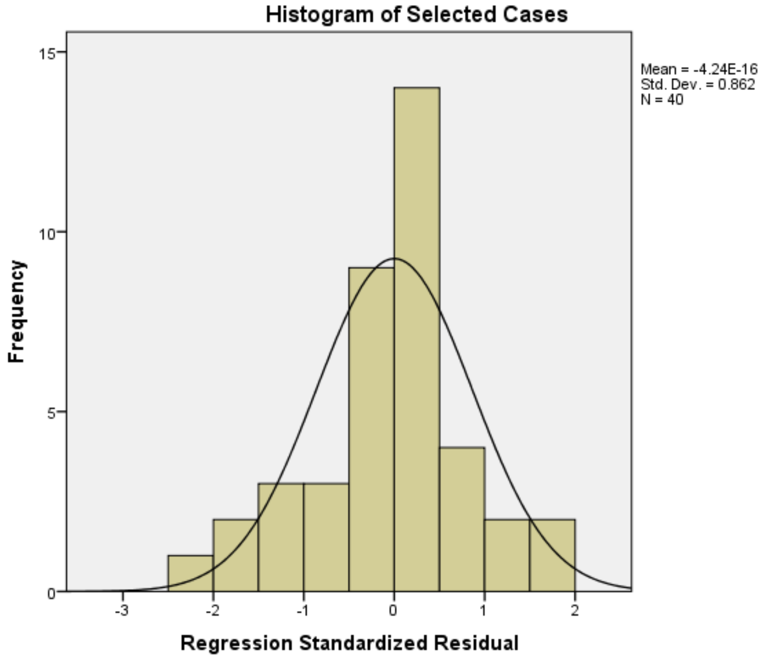
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	B6	-.071[b]	-.488	.628	-.081	.937
	B7	.227[b]	1.437	.159	.233	.748
	B11	.382[b]	2.761	.009	.418	.850
	B13	.324[b]	1.429	.162	.232	.363
	A8	-.171[b]	-1.175	.248	-.192	.893
	A9	-.187[b]	-1.297	.203	-.211	.904
	A11	-.377[b]	-2.957	.005	-.442	.977
	C1	-.169[b]	-1.221	.230	-.199	.993
2	A8	-.184[c]	-1.278	.211	-.220	.818
	A9	-.005[c]	-.028	.978	-.005	.680
	A11	-.352[c]	-2.812	.008	-.445	.914
	C1	-.234[c]	-1.786	.084	-.301	.948

a. Dependent Variable: REGR factor score 1 for analysis 1

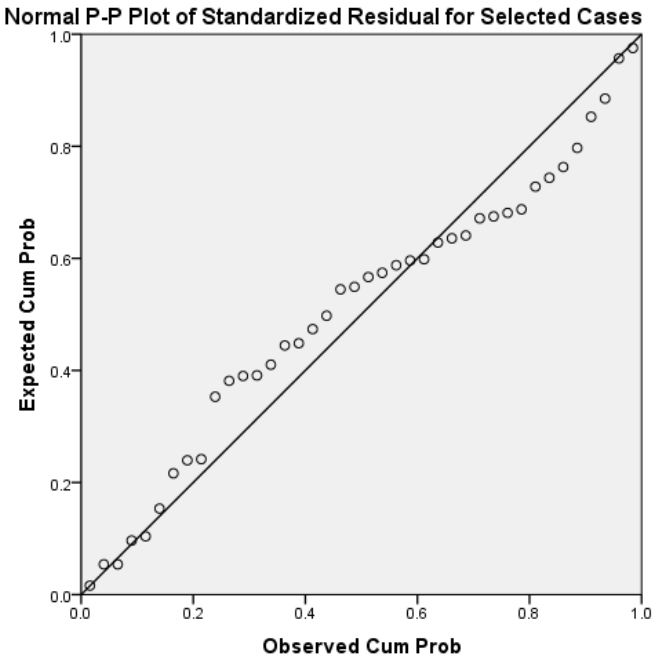
b. Predictors in the Model: (Constant), B12, B9

c. Predictors in the Model: (Constant), B12, B9, B6, B11, B7, B13

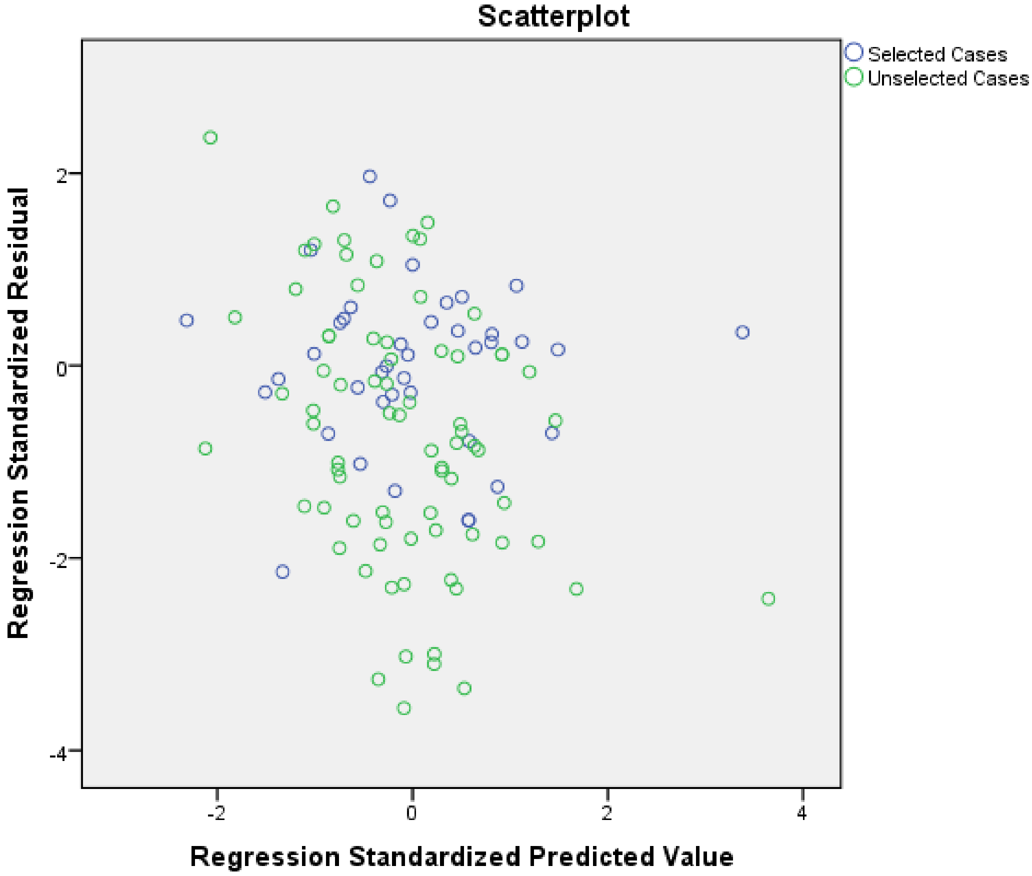
M.2 Charts



Histogram of Selected Cases
Mean = -4.24E-16
Std. Dev. = 0.862
N = 40
Frequency
15
10
5
0
-3
-2
-1
0
1
2
Regression Standardized Residual



Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
2
0
-2
-4
-2
0
2
4
Regression Standardized Predicted Value

Appendix N First Usage Behaviour Model

This appendix contains the outputs of the *first usage behaviour model* regression analysis and assumption testing that was discussed in Section 5.4.3.

N.1 Regression Analysis

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	B20, B18, B15, B17, B16, B19[c]	.	Enter
2	B5, B8, B1[c]	.	Enter
3	B4, B2[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 1

c. All requested variables entered.

Model Summary[d,e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 1 (Selected)				R Square Change	F Change	df1	df2	Sig. F Change	F10 = 1 (Selected)
1	.335[a]	.112	.037	.90160056	.112	1.494	6	71	.193	
2	.465[b]	.216	.112	.86583158	.104	2.996	3	68	.037	
3	.499[c]	.249	.124	.86006867	.033	1.457	2	66	.240	2.071

a. Predictors: (Constant), B20, B18, B15, B17, B16, B19

b. Predictors: (Constant), B20, B18, B15, B17, B16, B19, B5, B8, B1

c. Predictors: (Constant), B20, B18, B15, B17, B16, B19, B5, B8, B1, B4, B2

d. Unless noted otherwise, statistics are based only on cases for which F10 = 1.

e. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.288	6	1.215	1.494	.193[c]
	Residual	57.715	71	.813		
	Total	65.002	77			
2	Regression	14.025	9	1.558	2.079	.044[d]
	Residual	50.977	68	.750		
	Total	65.002	77			
3	Regression	16.181	11	1.471	1.989	.044[e]
	Residual	48.821	66	.740		
	Total	65.002	77			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

c. Predictors: (Constant), B20, B18, B15, B17, B16, B19

d. Predictors: (Constant), B20, B18, B15, B17, B16, B19, B5, B8, B1

e. Predictors: (Constant), B20, B18, B15, B17, B16, B19, B5, B8, B1, B4, B2

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.554	.417		1.329	.188	-.277	1.385
	B15	.080	.091	.168	.883	.380	-.101	.261
	B16	-.028	.115	-.056	-.242	.810	-.258	.202
	B17	-.032	.110	-.071	-.294	.770	-.251	.187
	B18	.070	.071	.124	.976	.332	-.072	.212
	B19	-.192	.133	-.355	-1.443	.153	-.458	.073
	B20	.013	.087	.024	.151	.880	-.161	.188

2	(Constant)	-.513	.563		-.912	.365	-1.636	.610
	B15	.044	.090	.092	.488	.627	-.136	.224
	B16	-.042	.113	-.084	-.369	.713	-.268	.184
	B17	.034	.120	.075	.283	.778	-.206	.274
	B18	.077	.069	.136	1.109	.271	-.061	.214
	B19	-.192	.132	-.354	-1.458	.149	-.455	.071
	B20	.076	.089	.135	.857	.394	-.101	.253
	B1	.235	.110	.338	2.135	.036	.015	.455
	B5	.053	.124	.057	.424	.673	-.195	.300
	B8	-.011	.135	-.013	-.081	.936	-.281	.259
3	(Constant)	-.871	.597		-1.458	.150	-2.062	.321
	B15	.071	.091	.148	.778	.439	-.111	.252
	B16	-.072	.114	-.145	-.633	.529	-.300	.156
	B17	.029	.119	.063	.242	.810	-.210	.267
	B18	.058	.070	.103	.829	.410	-.082	.198
	B19	-.173	.132	-.320	-1.315	.193	-.437	.090
	B20	.065	.091	.116	.714	.478	-.117	.247
	B1	.232	.113	.332	2.058	.044	.007	.456
	B5	.012	.127	.013	.095	.924	-.242	.266
	B8	-.015	.140	-.017	-.107	.915	-.295	.265
	B2	.076	.074	.133	1.025	.309	-.072	.225
	B4	.053	.068	.098	.772	.443	-.083	.188

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	B1	.359[b]	3.006	.004	.338	.789
	B5	.211[b]	1.735	.087	.203	.823

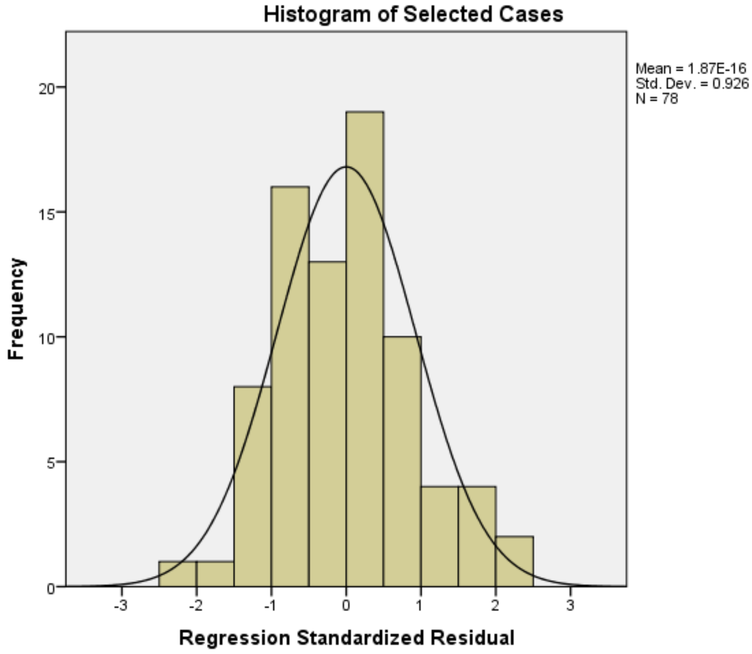
	B8	.207[b]	1.562	.123	.184	.697
	B2	.238[b]	2.108	.039	.244	.937
	B4	.148[b]	1.275	.207	.151	.918
2	B2	.178[c]	1.527	.131	.183	.834
	B4	.155[c]	1.364	.177	.164	.881

a. Dependent Variable: REGR factor score 1 for analysis 1

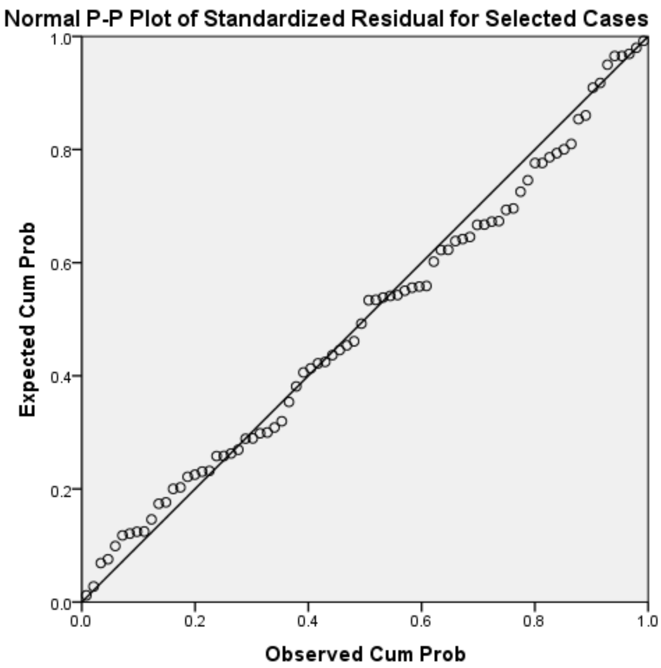
b. Predictors in the Model: (Constant), B20, B18, B15, B17, B16, B19

c. Predictors in the Model: (Constant), B20, B18, B15, B17, B16, B19, B5, B8, B1

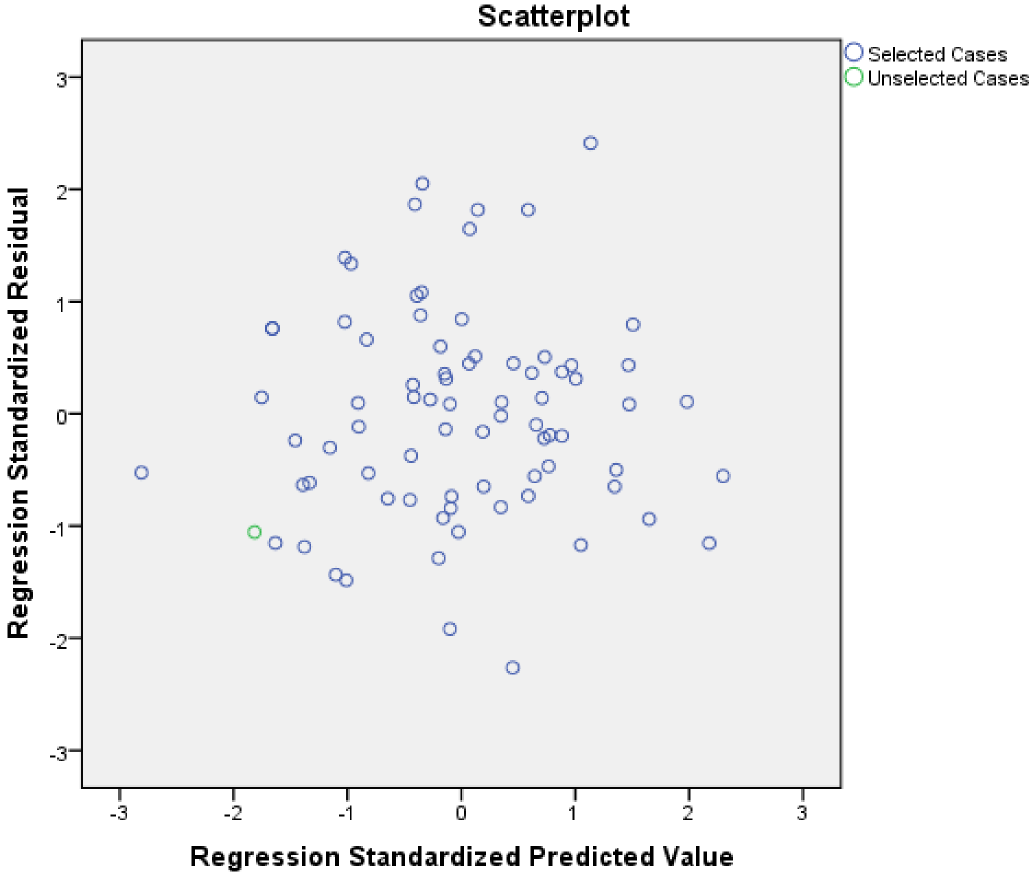
N.2 Charts



Histogram of Selected Cases
Mean = 1.87E-16
Std. Dev. = 0.926
N = 78
Frequency
0
5
10
15
20
-3
-2
-1
0
1
2
3
Regression Standardized Residual



Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
3
2
1
0
-1
-2
-3
-3
-2
-1
0
1
2
3
Regression Standardized Predicted Value

Appendix O Second Usage Behaviour Model

This appendix contains the outputs of the *second usage behaviour model* regression analysis and assumption testing that was discussed in Section 5.4.3.

O.1 Regression Analysis

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	B12, B9[c]	.	Enter
2	B7, B6, B13, B11[c]	.	Enter
3	C1, A8, A11, A9[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 1

c. All requested variables entered.

Model Summary[d,e]

Model	R	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 1 (Selected)			R Square Change	F Change	df1	df2	Sig. F Change	F10 = 1 (Selected)
1	.124[a]	-.012	.94330629	.015	.558	2	71	.575	
2	.446[b]	.128	.87569543	.184	3.847	4	67	.007	
3	.532[c]	.170	.85428907	.084	1.850	4	63	.130	1.914

a. Predictors: (Constant), B12, B9

b. Predictors: (Constant), B12, B9, B7, B6, B13, B11

c. Predictors: (Constant), B12, B9, B7, B6, B13, B11, C1, A8, A11, A9

d. Unless noted otherwise, statistics are based only on cases for which F10 = 1.

e. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.992	2	.496	.558	.575[c]
	Residual	63.178	71	.890		
	Total	64.170	73			
2	Regression	12.791	6	2.132	2.780	.018[d]
	Residual	51.378	67	.767		
	Total	64.170	73			
3	Regression	18.192	10	1.819	2.493	.014[e]
	Residual	45.978	63	.730		
	Total	64.170	73			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

c. Predictors: (Constant), B12, B9

d. Predictors: (Constant), B12, B9, B7, B6, B13, B11

e. Predictors: (Constant), B12, B9, B7, B6, B13, B11, C1, A8, A11, A9

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.276	.248		-1.115	.269	-.770	.218
	B9	.080	.118	.096	.680	.499	-.155	.316
	B12	.024	.080	.043	.303	.762	-.135	.184
2	(Constant)	-1.119	.374		-2.987	.004	-1.866	-.371
	B9	.034	.116	.041	.295	.769	-.197	.266
	B12	-.023	.077	-.040	-.291	.772	-.177	.132
	B6	-.025	.064	-.045	-.391	.697	-.152	.102
	B7	.222	.130	.211	1.706	.093	-.038	.482
	B11	.234	.196	.153	1.190	.238	-.158	.626
	B13	.190	.082	.274	2.309	.024	.026	.355

	(Constant)	.072	1.217		.059	.953	-2.360	2.505
	B9	-.016	.122	-.019	-.133	.895	-.260	.227
	B12	-.058	.082	-.102	-.706	.483	-.222	.106
	B6	-.003	.064	-.006	-.051	.960	-.131	.124
	B7	.245	.130	.233	1.883	.064	-.015	.504
3	B11	.185	.194	.122	.957	.342	-.202	.573
	B13	.175	.083	.251	2.108	.039	.009	.340
	A8	-.100	.137	-.093	-.731	.468	-.373	.173
	A9	-.037	.241	-.021	-.152	.879	-.519	.446
	A11	.079	.177	.056	.447	.657	-.275	.433
	C1	-.217	.096	-.269	-2.264	.027	-.409	-.026

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

Excluded Variables[a]

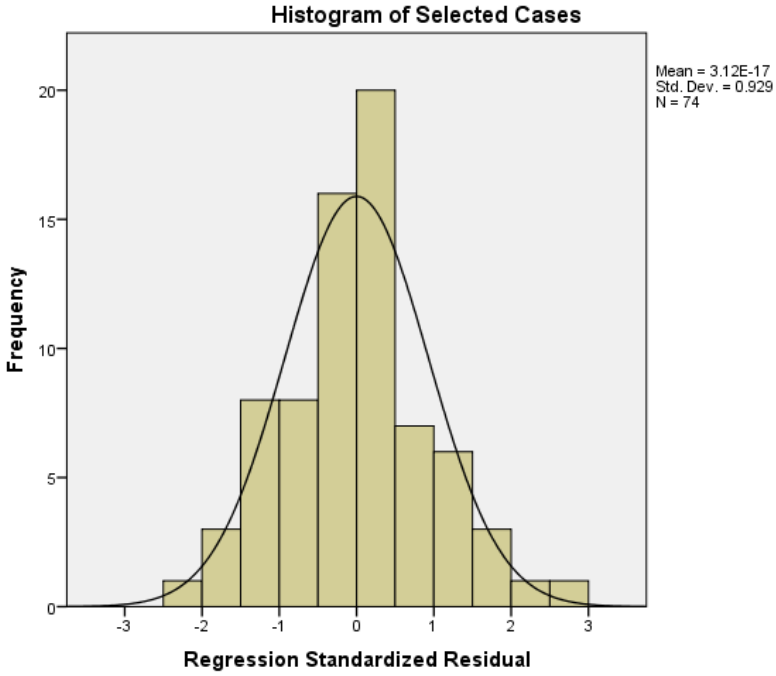
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
	B6	.028[b]	.232	.817	.028	.976
	B7	.328[b]	2.918	.005	.329	.990
	B11	.212[b]	1.649	.104	.193	.821
	B13	.341[b]	2.997	.004	.337	.960
1	A8	-.172[b]	-1.326	.189	-.157	.820
	A9	.085[b]	.601	.550	.072	.697
	A11	.000[b]	-.001	1.000	.000	.764
	C1	-.308[b]	-2.629	.011	-.300	.929
	A8	-.168[c]	-1.374	.174	-.167	.788
	A9	.074[c]	.558	.579	.069	.680
2	A11	.081[c]	.635	.528	.078	.737
	C1	-.291[c]	-2.616	.011	-.307	.886

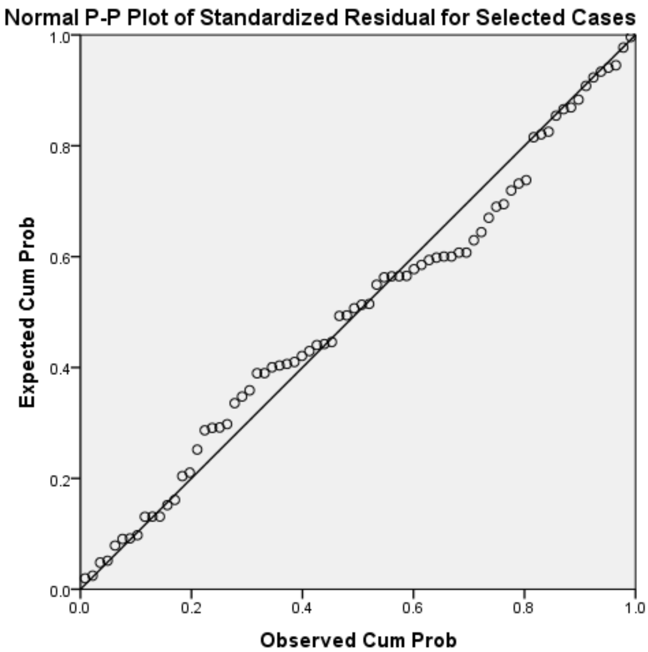
a. Dependent Variable: REGR factor score 1 for analysis 1

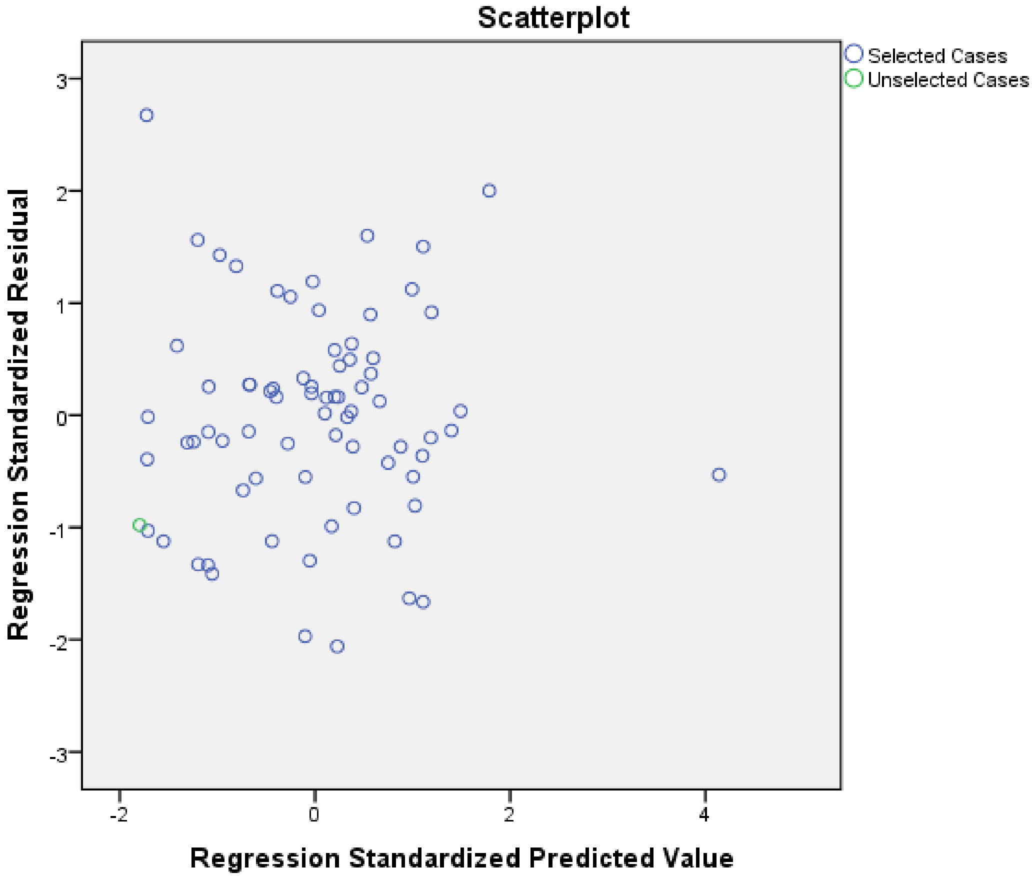
b. Predictors in the Model: (Constant), B12, B9

c. Predictors in the Model: (Constant), B12, B9, B7, B6, B13, B11

O.2 Charts


Histogram of Selected Cases
Mean = 3.12E-17
Std. Dev. = 0.929
N = 74
Frequency
20
15
10
5
0
-3
-2
-1
0
1
2
3
Regression Standardized Residual


Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
3
2
1
0
-1
-2
-3
-2
0
2
4
Regression Standardized Predicted Value

Appendix P Third Usage Behaviour Model

This appendix contains the outputs of the *third usage behaviour model* regression analysis and assumption testing that was discussed in Section 5.4.3.

P.1 Regression Analysis

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	F4, F2, F3[c]	.	Enter
2	F6, F9[c]	.	Enter
3	F23[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 1

c. All requested variables entered.

Model Summary[d,e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 1 (Selected)				R Square Change	F Change	df1	df2	Sig. F Change	F10 = 1 (Selected)
1	.275[a]	.076	.036	.89698551	.076	1.910	3	70	.136	
2	.462[b]	.213	.155	.83967383	.137	5.941	2	68	.004	
3	.763[c]	.582	.545	.61630425	.369	59.223	1	67	.000	1.862

a. Predictors: (Constant), F4, F2, F3

b. Predictors: (Constant), F4, F2, F3, F6, F9

c. Predictors: (Constant), F4, F2, F3, F6, F9, F23

d. Unless noted otherwise, statistics are based only on cases for which F10 = 1.

e. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.610	3	1.537	1.910	.136[c]
	Residual	56.321	70	.805		
	Total	60.931	73			
2	Regression	12.987	5	2.597	3.684	.005[d]
	Residual	47.944	68	.705		
	Total	60.931	73			
3	Regression	35.482	6	5.914	15.569	.000[e]
	Residual	25.449	67	.380		
	Total	60.931	73			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

c. Predictors: (Constant), F4, F2, F3

d. Predictors: (Constant), F4, F2, F3, F6, F9

e. Predictors: (Constant), F4, F2, F3, F6, F9, F23

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.565	.399		-1.414	.162	-1.361	.232
	F2	.146	.065	.271	2.246	.028	.016	.275
	F3	-.004	.056	-.010	-.072	.943	-.117	.108
	F4	.022	.075	.038	.298	.767	-.127	.171
2	(Constant)	-.861	.407		-2.115	.038	-1.673	-.049
	F2	.084	.064	.156	1.311	.194	-.044	.211
	F3	.032	.054	.076	.602	.549	-.075	.140
	F4	-.039	.072	-.066	-.535	.595	-.183	.105
	F6	-.079	.094	-.133	-.835	.407	-.267	.109
	F9	.303	.103	.485	2.956	.004	.098	.508

	(Constant)	-1.613	.314		-5.132	.000	-2.241	-.986
	F2	.059	.047	.110	1.261	.212	-.035	.153
	F3	.030	.040	.072	.767	.446	-.049	.110
3	F4	-.013	.053	-.023	-.253	.801	-.119	.093
	F6	-.038	.069	-.064	-.544	.588	-.176	.101
	F9	.066	.081	.106	.815	.418	-.096	.229
	F23	.456	.059	.696	7.696	.000	.338	.574

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

Excluded Variables[a]

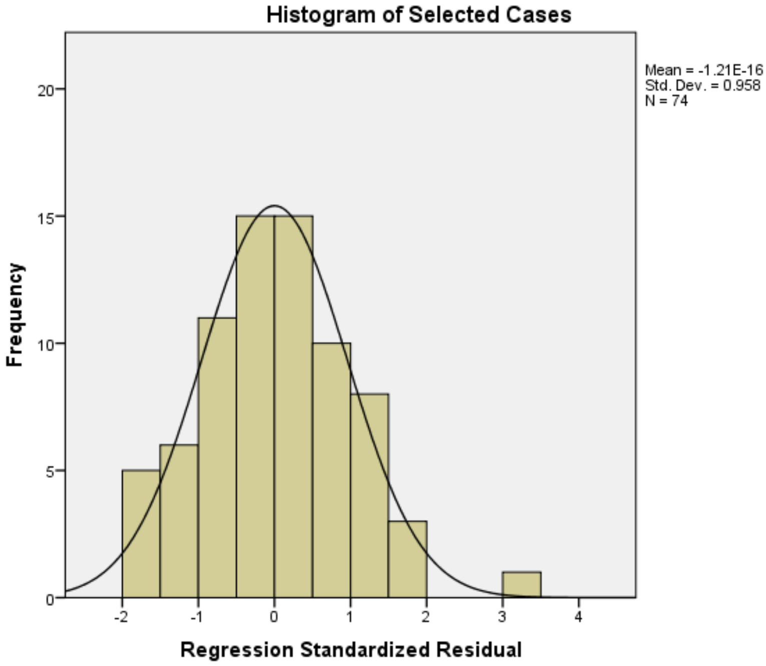
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
	F6	.200[b]	1.682	.097	.198	.909
1	F9	.389[b]	3.352	.001	.374	.857
	F23	.725[b]	9.067	.000	.737	.957
2	F23	.696[c]	7.696	.000	.685	.762

a. Dependent Variable: REGR factor score 1 for analysis 1

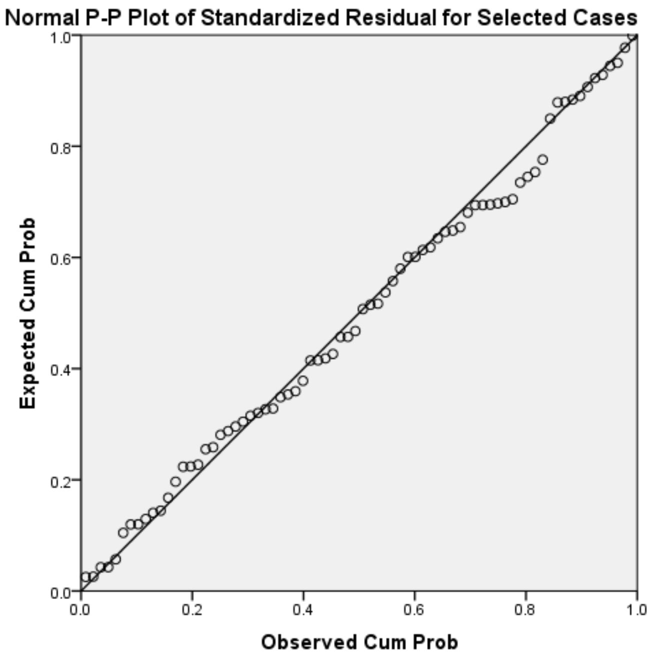
b. Predictors in the Model: (Constant), F4, F2, F3

c. Predictors in the Model: (Constant), F4, F2, F3, F6, F9

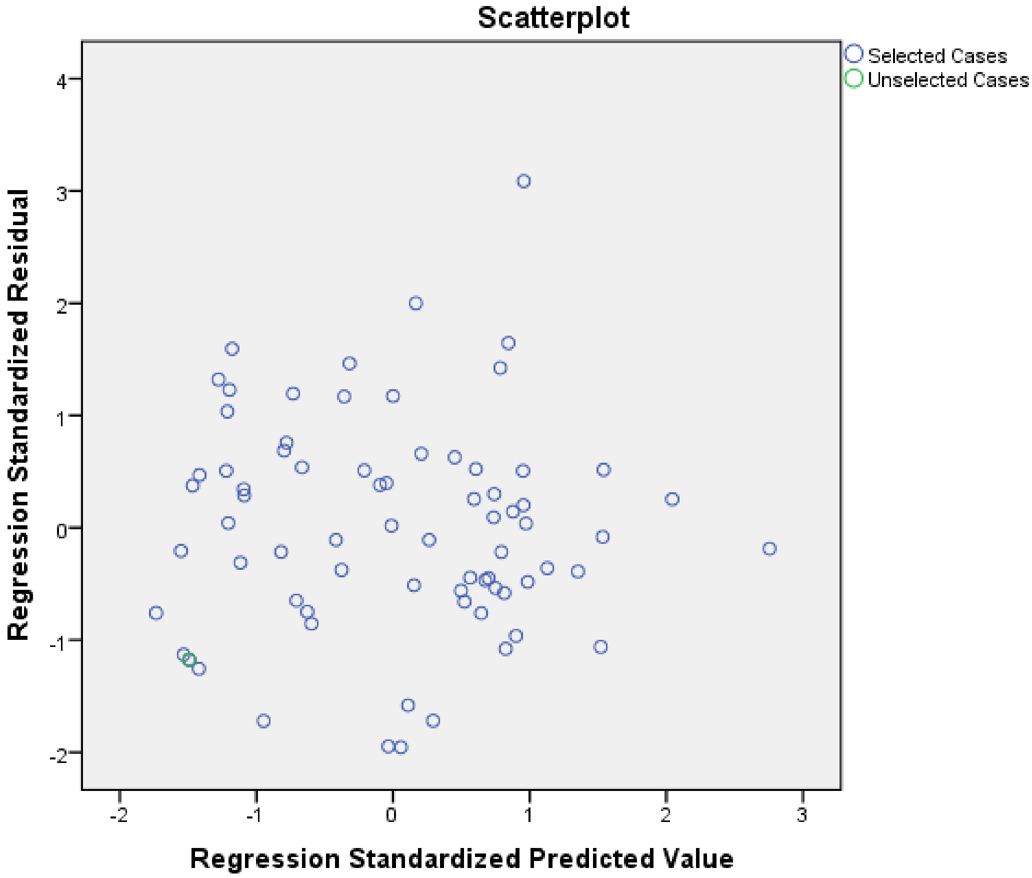
P.2 Charts



Histogram of Selected Cases
Mean = -1.21E-16
Std. Dev. = 0.958
N = 74
Frequency
20
15
10
5
0
-2
-1
0
1
2
3
4
Regression Standardized Residual



Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
4
3
2
1
0
-1
-2
-2
-1
0
1
2
3
Regression Standardized Predicted Value

Appendix Q Fourth Usage Behaviour Model

This appendix contains the outputs of the *fourth usage behaviour model* regression analysis and assumption testing that was discussed in Section 5.4.3.

Q.1 Regression Analysis

Variables Entered/Removed[a,b]

Model	Variables Entered	Variables Removed	Method
1	F8, F7[c]	.	Enter
2	F13[c]	.	Enter
3	F15, F16, F14[c]	.	Enter

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Models are based only on cases for which F10 = 1

c. All requested variables entered.

Model Summary[d,e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson Statistic
	F10 = 1 (Selected)				R Square Change	F Change	df1	df2	Sig. F Change	F10 = 1 (Selected)
1	.252[a]	.063	.037	.86263072	.063	2.432	2	72	.095	
2	.369[b]	.136	.100	.83414551	.073	6.001	1	71	.017	
3	.695[c]	.483	.437	.65941226	.347	15.204	3	68	.000	1.628

a. Predictors: (Constant), F8, F7

b. Predictors: (Constant), F8, F7, F13

c. Predictors: (Constant), F8, F7, F13, F15, F16, F14

d. Unless noted otherwise, statistics are based only on cases for which F10 = 1.

e. Dependent Variable: REGR factor score 1 for analysis 1

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.620	2	1.810	2.432	.095[c]
	Residual	53.577	72	.744		
	Total	57.197	74			
2	Regression	7.795	3	2.598	3.735	.015[d]
	Residual	49.402	71	.696		
	Total	57.197	74			
3	Regression	27.629	6	4.605	10.590	.000[e]
	Residual	29.568	68	.435		
	Total	57.197	74			

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

c. Predictors: (Constant), F8, F7

d. Predictors: (Constant), F8, F7, F13

e. Predictors: (Constant), F8, F7, F13, F15, F16, F14

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.640	.310		-2.066	.042	-1.257	-.022
	F7	.027	.074	.043	.363	.718	-.121	.175
	F8	.140	.070	.237	1.997	.050	.000	.281
2	(Constant)	-.887	.316		-2.806	.006	-1.517	-.257
	F7	.015	.072	.025	.215	.831	-.128	.159
	F8	.137	.068	.231	2.013	.048	.001	.273
	F13	.160	.065	.271	2.450	.017	.030	.291
3	(Constant)	-1.637	.286		-5.721	.000	-2.208	-1.066

F7	-.039	.058	-.063	-.674	.503	-.155	.077
F8	-.001	.058	-.001	-.010	.992	-.116	.115
F13	.018	.061	.030	.298	.767	-.103	.139
F14	.212	.094	.299	2.257	.027	.025	.399
F15	.162	.070	.248	2.302	.024	.022	.302
F16	.196	.087	.281	2.252	.028	.022	.370

a. Dependent Variable: REGR factor score 1 for analysis 1

b. Selecting only cases for which F10 = 1

Excluded Variables[a]

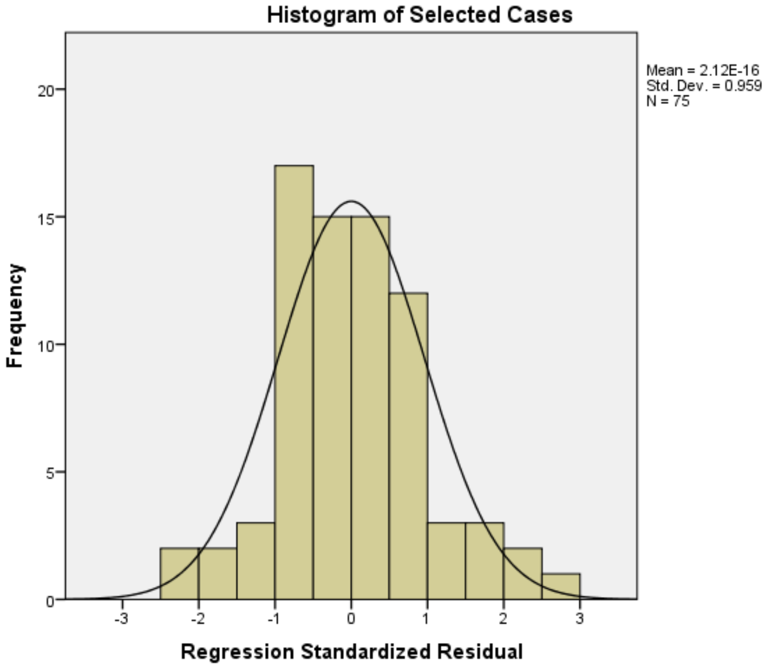
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	F13	.271[b]	2.450	.017	.279	.994
	F14	.589[b]	5.801	.000	.567	.868
	F15	.520[b]	5.146	.000	.521	.940
	F16	.590[b]	5.626	.000	.555	.829
2	F14	.590[c]	5.014	.000	.514	.656
	F15	.480[c]	4.639	.000	.485	.880
	F16	.557[c]	5.345	.000	.538	.807

a. Dependent Variable: REGR factor score 1 for analysis 1

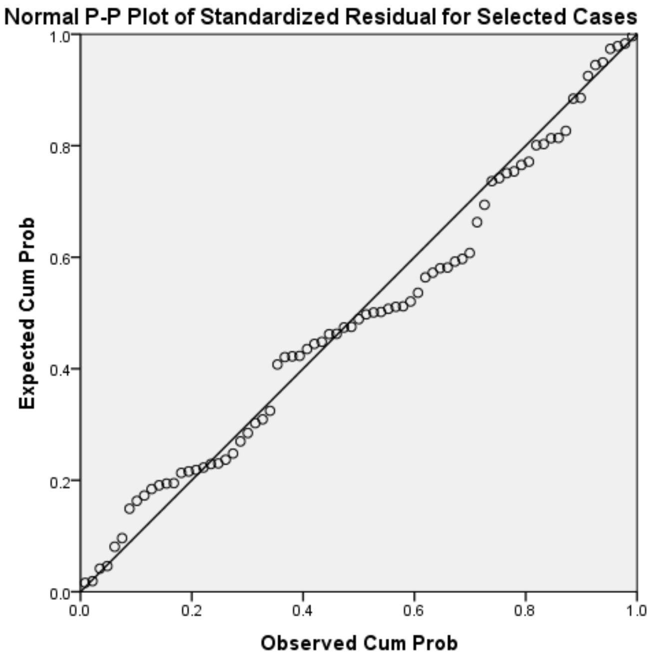
b. Predictors in the Model: (Constant), F8, F7

c. Predictors in the Model: (Constant), F8, F7, F13

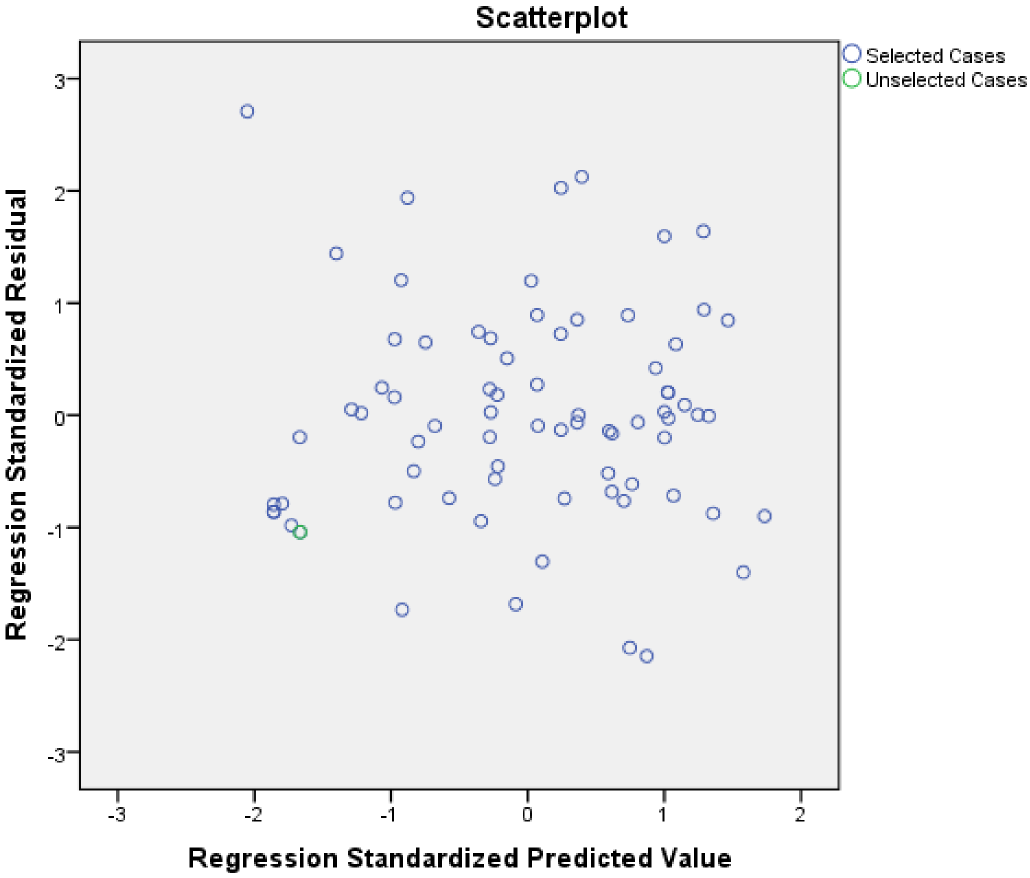
Q.2 Charts



Histogram of Selected Cases
Mean = 2.12E-16
Std. Dev. = 0.959
N = 75
Frequency
20
15
10
5
0
-3
-2
-1
0
1
2
3
Regression Standardized Residual



Normal P-P Plot of Standardized Residual for Selected Cases
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob


Scatterplot
Selected Cases
Unselected Cases
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-3
-3
-2
-1
0
1
2