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Electric vehicles adoption behaviour: Synthesising the technology readiness index with environmentalism values and instrumental attributes

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ABSTRACT

Since the introduction of Electric Vehicles (EVs) into the consumer market, the most important question has been how to persuade people to adopt this product. This is a very challenging mission for the industry and governments due to the nature of the product. It is a revolutionary innovation which means that it imposes major shifts in driving behaviour. The adoption rate however is slowly growing worldwide. Previous studies have shed light on the mechanism in which consumers express willingness to purchase EVs, mainly from the perspective of instrumental attributes (the perceived functional aspects of EVs) and the environmentalism values. This paper includes some behavioural traits to previous prediction models as plausible drivers to purchase EVs: Technology Readiness Index (TRI), and Desire for Unique Consumer Products (DUCP). These traits were synthesised with the aforementioned instrumental attributes and environmentalism values to offer a broad perspective on what drives the purchase intention of EVs.

This study was conducted in the UK through intercept survey, with a sample size of 336 individuals. The results suggest that TRI, manifested through innovativeness and insecurity towards technology, is a significant driver of EV purchase intention. In addition, three instrumental factors, namely driving range, convenience, and fuel costs, were found as significant predictors. Unlike previous studies that suggest EVs should be targeted towards environmentalist consumers, this study found weaker support for this claim. DUCP was also not found to be a significant factor, contrary to previous findings. The term EV in this article refers to battery-powered electric vehicle (BEV), which are fully electric vehicles with chargeable batteries.

1. Introduction

In recent years, climate change and its potential consequences and threats in the future have been well-publicised. Many people are concerned about the current level of carbon footprint, putting pressure on governments to pledge to deal with environmental problems. This has led to the development of government policies in leading economies to significantly reduce greenhouse gas emissions by investing in low-carbon energy sources, improving fuel standards in cars, and increasing energy efficiency wherever possible.

For example, The European Commission has set several targets in their Energy Strategy to be achieved by 2030, including the reduction of greenhouse gas emissions by 40 %, compared to 1990 levels. In the longer term, by 2050, the aim is to make the EU an economy with net-zero greenhouse gas emissions (https://ec.europa.eu/clima/policies/strategies/2050).

In the US, however, greenhouse emissions have increased by 4 % since 1990, and their level fluctuates each year due to several factors, such as the economy and the price of fuel. According to the United States Environmental Protection Agency (EPA), transportation fuel is responsible for 27 % of greenhouse gas emissions (https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions).

Evidently, there are multiple causes of environmental problems, which calls for a variety of solutions. Considering transportation's

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role in emitting greenhouse gas emissions, motivating consumers to adopt electric vehicles (EVs) is one of the viable options towards achieving the goal of greenhouse gas reduction. In a full lifecycle modelling study by Messagie (2014), it was calculated that electric vehicles emit significantly less greenhouse gas over their full product lifecycle than diesel engines, even if they are powered by the most carbon-intensive energy. Though the use of electric vehicles is not a perfect solution, due to concerns about the environmental friendliness of the current batteries, it would be a notable step towards sustainability commitments.

Despite the sluggish growth rate of electric cars, the latest report by the International Energy Agency (IEA) in 2020 illustrates promising figures in major markets. The global electric car stock hit the 10 million mark, a 43 % increase over 2019, and representing a 1 % stock share. Battery electric vehicles (BEVs) accounted for two-thirds of new electric car registrations and two-thirds of the stock in 2020. China, with 4.5 million electric cars, has the largest fleet, though in 2020 Europe had the largest annual increase to reach 3.2 million. (https://www.iea.org/reports/global-ev-outlook-2021/trends-and-developments-in-electric-vehicle-markets).

The latest figure from the Department for Transport in the UK, the country this research was conducted in, shows a registration rate of 67,100 passenger electric cars in 2020 (UK Government Statistics, 2020) (https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars), compared to 37,600 in 2019. This is promising, but the adoption curve is still at the early stage.

2. Research aims and contributions

The aim of this study is to synthesise the conceivable predictors of EV adoption, discussed in previous studies (environmental values and instrumental values), with two new behavioural constructs: (1) The Technology Readiness Index (TRI), and (2) Desire for Unique Selling Products (DUCP). Specifically, we further augment the previous studies that investigated the role of behavioural traits in adopting EVs. Incorporating these variables could further explain the adoption behaviour of EVs at the early stage of the innovation adoption curve.

Technology Readiness Index (TRI) is a widely used scale in understanding technology adoption behaviour, developed by Parasuraman and Colby (2000 and 2015). Since its publication in the year 2000, TRI has been reported as a powerful tool to predict the adoption of incremental and revolutionary technologies. It seems that very little empirical research has been conducted to examine the relationship between the four dimensions of TRI (Optimism, Innovativeness, Discomfort, and Security) and the intention to adopt an EV.

In addition to TRI, intention to adopt an EV could also be a factor of a desire to adopt a unique consumer product or DUCP (Lynn and Harris, 1997). In other words, adopting an EV could potentially be a symbol of uniqueness and represent one's social status. The study by Schuitema et al. (2013) in the UK found that an EV can be adopted to express a sense of self-identity and pride, as illustrated in their questionnaire survey:

'*I would feel proud of having a plug-in hybrid electric car/plug-in fully electric car outside my house*'. This would raise a question of whether the general trait of DUCP could be a significant predictor of EV purchase or not.

In summary, this paper postulates that willingness to adopt EVs should be the function of: (1) Overall Technology Readiness (TR) and its dimensions, (2) Instrumental Attributes (as widely studied by previous researchers), (3) Desire for Unique Consumer Products (DUCP), and (4) Environmentalism Values (which is a popular variable in recent studies).

3. Review of previous studies

Through the lens of academia, there have been several studies concentrating on the factors that drive EV adoption intentions (e.g. Jabeen et al. 2012; Moons and De Pelsmacker, 2012; Hahnel et al. 2014; White and Sintov, 2017; and Barbarossa et al. 2015). A review of previous studies reveals we can place the predictors of EV adoption into three categories: (1) the instrumental attributes (the functional factors related to electric vehicles, such as battery charge, charging convenience, and driving range), (2) the government policies and incentives, and (3) the environmental values and social responsibilities of consumers. Table 1 provides a summary of these studies and their key results. Most studies focused on purchase intention, but there are also some studies that focused on the motivating factor of actual adopters of EVs.

As this table suggests, previous studies have never reached consistent results regarding the factors that can predict EV adoption behaviour. Several studies had quantified the relationship between environmentalism (or concern for the environment) and willingness to adopt EVs (e.g. Heffner et al.2007; Hahnel et al.2014; White and Sintov, 2017; Barbarossa et al. 2015). However, some studies, such as Jabeen et al. (2012), found that the buyers of EVs in Australia do not recommend buying an EV due to environmental concerns, but due to new technology and some instrumental factors, such as charging convenience, and saving on fuel costs. Other aspects of instrumental values, such as maintenance costs and charging convenience, have consistently been reported as significant factors (Schuitema et al., 2013; Jabeen et al., 2012; Graham-Rowe et al., 2012; Rezvani et al., 2015, White and Sintov,2017). Symbolism, attitude, and identity were also popular predictors in previous studies (Table 1).

4. Hypotheses

4.1. Environmentalism values and adoption of EVs

The literature has used many labels and terms to describe the behaviour of an individual who values protecting the environment and/or would express environmental concerns. Examples of terms used in the literature include; Environmentalism, Concern for the Environment, Environmental Values, Environmentalist Self Identity, and Green Consumer Values. Hence, different measurement

Table 1
Predictors of EV adoption: Summary of the previous studies.

Author	Predictors	Methodology	Sample Size & Sample Characteristics	Outcome Variable(s)	Key Results
Heffner et al. (2007)	Symbolism	Qualitative Interviews	25 households in California who purchased a hybrid electric vehicle	How social meanings (denotations) and personal meanings (connotations) related to vehicle purchase?	– Buying an EV is a symbol of preserving and environment, which in turn is connected to more connotations, such as ethics and caring for others. – EV as a new technology was a motivating factor.
Jabeen et al. (2012)	– Confidence in environmental performance of an EV – Concern for environmental changes – Willingness to learn technology – Perceived EV benefits	Online survey & focus group	11 participants in the focus group and 43 participants in the online survey. Participants were actual EV drivers and those who experienced driving an EV in Australia.	– Willingness to recommend and purchase an EV	– Environmental concerns have no impact on recommend EV purchase. – Willingness to learn technology is a significant factor – Charging convenience is positively related to willingness to recommend an EV – Saving on travel costs is not a significant factor – Driving range is a significant barrier
Graham-Rowe et al. (2012)	No predictor was specified since the methodology was qualitative interviews.	Qualitative interviews after trying an EV for seven days	40 participants with intention of buying a new car within the next two years in the UK.	Willingness to purchase an EV	– Many drivers were concerned about the costs. – EV was judged as substandard as opposed to internal combustion cars. – There was a concern about charging the EV – Drivers believe that EV is environmentally friendly – Drivers were concerned about the perceived identities connected with this car choice
Moons and De Pelsmacker (2012)	– Attitude – Subjective norm peers – Subjective norm media – Emotion towards EV – Instrumental aspects of an EV (charging convenience, range etc) – Socio-demographic variables	Online survey through snowball sampling	1202 participants from general public in Belgium.	Usage intention of an electric car.	– Emotion, attitude, and subjective norms are the significant predictors. – Environmental concerned group has a positive attitude towards EVs – None of the socio-demographic factors were found to be influential in willingness to pur-chase an EV
Egbue and Long (2012)	EV knowledge, experience and interest.	Internet-based survey	481 students, faculty and staff at a technological university that specialises mainly in science	Barriers of adopting alternative fuel vehicles, including EVs	– Environmental benefits of an EV is an influential factor, but it comes after costs and performance – Students with technology background subjects expressed strong interest towards alternative fuel vehicles – Cost is the main attribute of purchasing decision
Jensen et al. (2013)	– Experience of using an EV – Attitude towards the environment	Experimental research. Participants experienced driving an EV.	369 households in Denmark who had bought a car within the last 5 years or intended to buy a car within the next 5 years	Preference of choosing an EV over a conventional car	– Individual preferences change significantly after a real experience with an EV – Environmental concern has a positive effect on the preference for EVs
				Intention to purchase an EV	

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Table 1 (*continued*)

Author	Predictors	Methodology	Sample Size & Sample Characteristics	Outcome Variable(s)	Key Results
Schuitema et al. (2013)	Instrumental, hedonic and symbolic attributes	National online survey in the UK	2728 members of general public who own a car		Symbolic, hedonic and instrumental attributes are associated with EV adoption intention
Carley et al. (2013)	– Socio-demographic factors – Vehicle attributes of interest – Awareness of EVs and infrastructure – Attitude towards EVs	Online survey	2302 adult drivers in 21 urban areas in the US who have valid driver's licenses	Intention to purchase an EV	– There is low interest in purchasing EVs – Consumers who are interested are highly educated and environmentally concerned
Barbarossa et al. (2015)	– Green self-identity – Care for the environmental consequences of using cars – Green moral obligations – Attitude towards EVs	Online survey	2005 respondents in three countries: Belgium, Denmark, Italy. Stratified quota sampling was performed in each country from people who hold a driver's license.	Intention to purchase an EV	– In Denmark, electric car adoption is mainly influenced by green self-identity – In Belgium, electric car adoption is mainly influenced by the environmental consequences of using cars – In Italy, electric car adoption is mainly influenced by green self-identity and moral obligation
Noppers et al. (2015)	– Instrumental attributes – Symbolic attributes – Environmental attributes	Online survey	2974 individuals from the general public selected from an online platform in the Netherlands.	Intention to purchase an EV	– Potential early adopters would value symbolic attributes more than environmental and instrumental attributes – All attributes mentioned as predictors have a significant impact on EV purchase intention
Rezvani et al. (2015)	– Emotion – Symbolic values – Joy – Pride – Instrumental values – Innovativeness – Environmental attributes	Systematic Literature Review	Not applicable due to the nature of the methodology	Intention to purchase an EV	– Purchase cost of an EV is found to be a barrier. – Joy, pride and positive emotions from driving an EV and environmental concerns positively influence adoption intentions.
Helveston et al. (2015)	Government subsidies	Survey experiment	Conjoint survey on vehicle preferences in the US and China	Vehicle preference	– Chinese are more willing to adopt an EV than Americans – Government subsidies have no impact on purchase decision in either country
Tamor and Milaćić (2015)	Vehicle usage in two-vehicle households was analysed	Analysis of public data	Data drawn from the Puget Sound Regional Council Traffic Choices Study	Acceptance of EVs	– With in-household flexibility, acceptance of EVs with modest range can be very high – Short range EVs in 2VHH are far more cost-effective than long-range all-purpose EVs.
Hardman et al. (2016)	– Instrumental attributes – Psychographic variables	Questionnaire Survey	Data from owners of EVs from online forums. The sample size was 340.	Comparison of early and later adopters.	– Early adopters are more educated and have higher income – Early adopters are more sympathetic
Morton et al. (2016)	– Consumer Innovativeness – Socio-demographic variables	Paper-based survey	400 households in Dundee and Newcastle upon Tyne in the UK	Preference towards a PHEV[1] and EV[2].	– Females are less inclined to prefer an EV – The desire to own a technology is a significant factor in EV and PHEV preference.
Barbarossa et al. (2017)	– Self-transcendence – Self-enhancement – Openness-to-change	Online survey in three European countries: Belgium, Denmark, and	2010 respondents from general population with a driver's license	Intention to purchase an EV	Self-enhancement values and green self-identity are significant drivers of EV adoption intention.

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Table 1 (*continued*)

Author	Predictors	Methodology	Sample Size & Sample Characteristics	Outcome Variable(s)	Key Results
	– Conservation	Italy.			
Javid and Nejat (2017)	– Income – Education – Charging station – Gas price – Travel time	Secondary dataset: California Household Travel Survey	Sample size is 16,348 individuals who have purchased a new car within the past two years	EV penetration rate	– Income, education, charging station, and gas price significant factors – Travel time and vehicle in household in EV adoption – Level of EV penetration in a county is associated with infrastructure
White and Sintov (2017)	– Symbolic attributes reflected as a self-identity – Environmentalism – Social Innovativeness – Instrumental attributes	Mail Survey	Sample size of 355 randomly selected individuals in California	EV purchase intention	– Environmentalist and Innovator symbolism predict EV adoption – Environmentalist and Social Innovator symbols mediate the relationship between concern for the environment and EV purchase – Perceived maintenance cost was found as a significant factor in purchase intention of an EV
Hardman et al. (2018)	Charging infrastructure	Literature Review	Qualitative Literature Review that focused on charging stations	Consumer preference for charging EVs	– Home charging is the most important infrastructure to convince consumers to purchase an EV – Interoperability of charging points is a key factor too
Lee et al. (2019)	Household income	Cross-sectional questionnaire survey	18,000 PEV owners in California. Cluster analysis was performed.	Diffusion of EVs	– High income families may not be the largest group of adopters anymore – To speed up the adoption rate, more focus is needed on middle-income families

Table 2
EV Uptake in the UK Regions.

Rank	Regions	Electric Vehicles	Total Vehicles	% of Electric Vehicles
1	London	23,613	2,878,482	0.82 %
2	West Midlands	27,406	3,538,515	0.77 %
3	South East	40,943	5,883,582	0.70 %
4	East	25,584	3,784,529	0.68 %
5	South West	22,162	3,725,333	0.59 %
6	Yorkshire and The Humber	13,563	2,788,417	0.49 %
7	Scotland	11,941	2,783,516	0.43 %
8	East Midlands	10,544	2,760,910	0.38 %
9	North West	10,504	3,613,042	0.29 %
10	North East	3,488	1,295,649	0.27 %
11	Northern Ireland	2,606	1,074,018	0.24 %
12	Wales	4,030	1,771,908	0.23 %

Source: BGL Group (2019)

scales have also been developed. (Jensen et al., 2013; White and Sintov, 2017; Noppers et al., 2015; Rezvani et al., 2015; Haws et al., 2014).

What is evident is that all these terms and labels are rooted in Value Theory by Schwartz (1992), which suggests environmental values, manifested through 'protecting the environment' and 'unity with nature', as one of the ten values that drive people's behaviour. In terms of definitions, the one suggested by Sutton (2019) seems very relevant to use for environmentally friendly products, such as an EV:

> *"Environmentalism refers to those approaches to society/nature relations which emphasises the benefits to human beings of natural objects, and to attempts to rectify problems of environmental damage and pollution through technological means." (*Sutton, 2019*. p.5).*

This definition clearly explains the mechanism behind environmentalist self-identity, as also used in previous studies (e.g. White and Sintov, 2017; Rezvani et al., 2015). Individuals can express status and their concern for the environment by adopting environmentally friendly products, such as electric cars; this becomes part of their self-identity. In fact, White and Sintov (2017) used both Environmentalist Self- Identity and Concern for Environment as separate variables, and found that environmentalist self-identity mediates the relationship between concern for the environment and EV adoption intention. Green Consumer Values is also another term, which is very similar to Environmentalist Self-Identity, defined as 'the tendency to express the value of environmental protection through one's purchases and consumption behaviours' (Haws et al., 2014. p.336). As summarised in Table 1, there is relatively strong support to argue that concern for the environment or green consumer values would predict the EV adoption intention. As a result, the following hypothesis is suggested:

H1: Green consumer values, expressed in an individual's behaviour, positively impact intention to adopt EVs.

4.2. Instrumental attributes and EV adoption behaviour

Linked to the utilitarian benefits theory, instrumental attributes refer to benefits derived from the use of products, such as quality, service, price, and convenience (Noppers et al., 2015; Schuitema et al., 2013; White and Sintov, 2017). Put simply, it is about how a product functions, which in this research, is about how an individual perceives the performance of an EV. The important instrumental attributes of an EV, supported strongly by previous studies, are purchase price, range, charging convenience, and maintenance costs (White and Sintov, 2017; Jabeen et al., 2012; Graham-Rowe et al., 2012; Noppers et al., 2015; Schuitema et al., 2013). Negative attitudes towards these attributes will certainly contribute to rejection or postponement of purchase. For example, in one survey in the U.S, the purchase price was listed as one of the barriers to EVs adoption (Carley et al., 2013). Even saving on the cost of fuel, though appreciated by consumers, does not necessarily lead to purchase (Carley et al., 2013). Other attributes that have been shown to have a significant impact on purchasing EVs are range and convenience of charging (Graham-Rowe et al. 2012). The summary of previous studies on the relationship between instrumental attributes and EV purchase intention is presented in Table 1.

The following hypotheses are suggested with regard to instrumental attributes and adoption of EVs:

H2: Perceived purchase cost will have a negative impact on the intent to adopt an EV.
H3: Perceived maintenance costs will have a negative impact on the intent to adopt an EV.
H4: Perceived fuel costs of EVs (compared to fossil fuel cars) will have a negative impact on the intent to adopt an EV.
H5: Perceived convenience of charging the battery of an EV will have a positive impact on the intent to adopt an EV.
H6: Perceived driving range will have a positive impact on the intent to adopt an EV.

4.3. Technology readiness (TR) and adoption of EVs

Previous studies have highlighted the prominent role of people's feelings toward technology (positive or negative) to their propensity to adopt technologies (i.e. Davis et al. 1989; Mick and Fournier, 1998; Chen and Li, 2010; Fisk et al. 2011; Meuter et al., 2003).

Table 3
Descriptive Statistics of the Measurement Items.

	Mean	Std. Deviation	Measurement Level
I perceive the purchase cost of an Electric Vehicle compared to a standard vehicle is…	4.06	0.769	1- Much Less, 2 = Somewhat less, 3 = No difference, 4 = Somewhat more, 5 = Much more
I perceive the maintenance cost of an Electric Vehicle compared to a standard vehicle is…	3.61	0.952	1- Much Less, 2 = Somewhat less, 3 = No difference, 4 = Somewhat more, 5 = Much more
I perceive the fuel cost of an Electric Vehicle compared to a standard vehicle is…	1.67	0.785	1- Much Less, 2 = Somewhat less, 3 = No difference, 4 = Somewhat more, 5 = Much more
My perception about the convenience of charging the battery of an electric is…	2.49	0.911	1- Much Less, 2 = Somewhat less, 3 = No difference, 4 = Somewhat more, 5 = Much more
What range would you say an electric vehicle can drive? (Please write your answer)	184.21	96.980	This could be any number.
How likely is it that you will purchase an electric vehicle in the near future?*	4.10	1.315	1 = Extremely Unlikely, 2 = Very Unlikely, 3 = Unlikely, 4 = Neutral 5 = Likely, 6 = Very Likely, 7 = Extremely Likely
How likely are you willing to pay a higher price to purchase an electric vehicle compared to a fuel car?*	4.22	1.254	1 = Extremely Unlikely, 2 = Very Unlikely, 3 = Unlikely, 4 = Neutral 5 = Likely, 6 = Very Likely, 7 = Extremely Likely
New technologies contribute to a better quality of life.	3.39	0.888	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
Technology gives more freedom of mobility.	3.29	0.848	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
In general, I am among the first in my circle of friends to acquire new technology when it appears.	3.00	1.044	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
Technology gives people more control over their daily lives.	3.13	0.930	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
Technical support lines are not helpful because they don't explain things in terms I understand.	3.14	0.885	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
Technology makes me more productive in my personal life.	3.25	0.975	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
Other people come to me for advice on new technologies.	2.80	0.986	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I can usually figure out new high-tech products and services without help from others.	3.07	1.024	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I keep up with the latest technological developments in my areas of interest.	3.11	1.076	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.	2.94	0.920	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree

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Table 3 (*continued*)

	Mean	Std. Deviation	Measurement Level
Sometimes, I think that technology systems are not designed for use by ordinary people.	2.92	0.882	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
There is no such thing as a manual for a high-tech product or service that's written in plain language.	2.85	0.884	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
People are too dependent on technology to do things for them.	3.16	0.947	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
Too much technology distracts people to a point that is harmful.	3.17	0.992	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
Technology lowers the quality of relations by reducing personal interaction.	3.34	1.027	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I do not feel confident doing business with a place that can only be reached online.	3.00	1.009	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I am very attracted to rare objects.	2.77	0.967	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I tend to be a fashion leader rather than a fashion follower.	2.73	0.949	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I am more likely to buy a product if it is scarce.	2.75	1.024	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I would prefer to have things custom made than to have them ready made.	2.88	0.991	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I enjoy having things that others do not.	3.18	0.935	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I rarely pass up the opportunity to order custom features on the products I buy.	2.76	0.999	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I like to try new products and services before others do.	2.95	1.015	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
I enjoy shopping at stores that carry merchandise that is different and unusual.	3.22	0.987	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree
It is important to me that the products I use do not harm the environment.	5.01	1.095	1 = Entirely Disagree, 2 = Mostly Disagree, 3 = Somewhat Disagree, 4 = Neither Agree or Disagree, 5 = Somewhat Agree, 6 = Mostly Agree 7 = Entirely Agree
I consider the potential environmental impact of my actions when making many of my decisions.	4.81	1.136	1 = Entirely Disagree, 2 = Mostly Disagree, 3 = Somewhat Disagree, 4 = Neither Agree or

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Table 3 (*continued*)

	Mean	Std. Deviation	Measurement Level
			Disagree, 5 = Somewhat Agree, 6 = Mostly Agree 7 = Entirely Agree
My purchase habits are affected by my concern for our environment.	4.76	1.105	1 = Entirely Disagree, 2 = Mostly Disagree, 3 = Somewhat Disagree, 4 = Neither Agree or Disagree, 5 = Somewhat Agree, 6 = Mostly Agree 7 = Entirely Agree
I am concerned about wasting the resources of our planet.	5.05	1.140	1 = Entirely Disagree, 2 = Mostly Disagree, 3 = Somewhat Disagree, 4 = Neither Agree or Disagree, 5 = Somewhat Agree, 6 = Mostly Agree 7 = Entirely Agree
I would describe myself as environmentally responsible.	4.82	1.049	1 = Entirely Disagree, 2 = Mostly Disagree, 3 = Somewhat Disagree, 4 = Neither Agree or Disagree, 5 = Somewhat Agree, 6 = Mostly Agree 7 = Entirely Agree
I am willing to be inconvenienced in order to take actions that are more environmentally friendly.	4.84	1.126	1 = Entirely Disagree, 2 = Mostly Disagree, 3 = Somewhat Disagree, 4 = Neither Agree or Disagree, 5 = Somewhat Agree, 6 = Mostly Agree 7 = Entirely Agree

* This is a dependent variable that measures purchase intention.

For example, in a study by Meuter et al. (2003), technology anxiety was found to be a strong factor in using self-service technologies in the retail environment. A similar study by Lin and Hsieh (2006) found that technology readiness has a positive impact on customer satisfaction and behavioural intentions towards self-service technologies.

Technology by itself can be paradoxical, meaning that consumers can demonstrate contradictory behaviour when they use a technology (Mick and Fournier, 1998). For example, a technology can assimilate people whilst it can also lead to human separation. Thus, it is important to understand the feelings and paradoxes in adopting a new technology.

The Technology Readiness Index (TRI) by Parasuraman and Colby (2015) is a popular measurement to understand and segment consumers based on their propensity to embrace and use cutting-edge technologies. The construct has four dimensions that sometimes can lead to paradoxical states: **Optimism**, **Innovativeness, Discomfort,** and **Insecurity**. Optimism and Innovativeness are classified as motivators; and Discomfort and Insecurity are classified as inhibitors of adopting a technology.

Since the publication of its first version in the year 2000, researchers have used the TRI in a variety of contexts in over two dozen countries. According to Parasuraman and Colby (2015), the scale works well to predict the ownership and willingness to purchase revolutionary technologies. However, the scale has been predominantly used against the ownership of online technologies (online banking, for example) and self-service machines (e.g. Fisk et al., 2011; Moon and Kim, 2001; Morris and Turner, 2001; Meuter et al. 2003). All these technologies were revolutionary at the time of their introduction. The scale is expected to be applicable as one of the key indicators of intention to purchase EVs, and there is no doubt that EVs are representative of revolutionary technologies since it imposes radical changes in driving and fuels consumption behaviour.

Table 4
ACORN Classification and Driving Behaviour.

Consumer Classification	Description & Driving Behaviour
Affluent Achievers	Wealthy people who live in the countryside and suburbs. They are most likely commuters and drive high mileage.
Rising Prosperity	They are either city sophisticates or career climbers. Many of them living in flats and townhouses. They are most likely going to commute to work either by public transport or drive low mileages locally. Few may still do high mileage motorway driving.
Comfortable Communities	There are six further sub categories (check ACORN guidelines for more detail) but the majority of them live in countryside and suburban areas. Their driving behaviour is likely similar to affluent achievers.
Financially Stretched	They are students, striving families, semi-skilled workers, and poor pensioners. Most likely, the majority of them do not have a car and mainly rely on public transport. They live in small flats, social houses, or post-war traced houses. Their income is mostly below the national average, and many of them do not have a credit card.
Urban Adversity	This category contains the most deprived areas of large and small towns. The level of people having difficulties with debt or having been refused credit approaches double the national average. We do not expect this group to own a car, so they use cheap public transport.
Not Private Households	The postcodes in this category are mainly for business parks and communal populations. Since they are not private households, it is not applicable to this study, but it is presented as extra information.

Table 5
Participants characteristics.

	Frequency	Percent
Male	164	48.8 %
Female	172	51.2 %
I am a high mileage driver on motorways.[1]	104	31 %
I am a local driver, making local mileage, driving predominantly.[2]	135	40.2 %
I am mainly dependent on a friend or family members vehicle for mobility needs.[3]	13	3.9 %
I am a city resident and mainly use public transport.[4]	31	9.2 %
I am a rural rider who mainly uses public transport.[5]	10	3 %
I am a rural rider who uses my own car.[6]	43	12.8 %
My age is:		
20–29	136	40.5 %
30–39	78	23.2 %
40–49	77	22.9 %
50–59	38	11.3
60+	7	2.1 %

1- Affluent Achievers, Comfortable Communities and possibly Rising Prosperity.
2- Rising Prosperity.
3- Financially Streched.
4- Rising Prosperity.
5- Urban Adversity.
6- Affluent Achievers and Comfortable Communities.

The authors of the TRI scale (Parasuraman and Colby, 2015) have suggested that there are two ways in which TRI can be used in research: (1) Using the full 16-item scale that measures four dimensions of technology readiness, (2) Calculating an overall TR score, which captures the overall technology readiness. This paper used both approaches and formed hypotheses accordingly to predict the EV adoption behaviour.

Based on the theory of innovation diffusion (Rogers, 2010), this study suggests that people who exhibit a higher propensity to adopt a new product or a new technology in general, are more willing to purchase EVs, and would ignite the innovation adoption curve. The hypothetical relationships between the four dimensions of TRI and EV adoption are as follows:

4.3.1. Optimism and adoption of EVs

Optimism is about 'a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives' (Parasuraman, 2000: 311). If customers feel that they are in control of technology and it offers them flexibility in life, there will be a higher probability of adoption, as stated in some previous studies (Liljander et al., 2006). It is expected that people who are optimistic towards technology in general will denote a favourable attitude toward electric cars. This aspect of TRI could also be explained by the general attitude and interests of consumers towards an EV. There is strong support in previous studies that people who have a positive attitude towards an EV (either through their actual purchase or through their general interest) are more willing to purchase an EV or recommend it to others (Egbue and Long, 2012; Moons and De Pelsmacker, 2012; Jensen et al., 2013; Carley et al., 2013).

4.3.2. Innovativeness and adoption of EVs

Innovativeness, defined as 'a tendency to be a technology pioneer and thought leader (Parasuraman, 2000: 311), seems to be the most often studied concepts compared to other dimensions of TRI. The concept is rooted in the opinion leadership theory (Keller and Berry, 2003) that is also applied to the innovation diffusion concept. The innovators are very influential in convincing others to adopt a new product due to their opinion leadership characteristics (Baumgartner and Steenkamp, 1996; Rogers 2010, and Salari and Shiu, 2015). They also tend to be highly educated and have a tendency to adopt a new technology earlier than others (Goldsmith and Hofacker, 1991). Consumer innovativeness has been specifically studied by Morton et al. (2016) as a predictor of purchasing an EV and PHEV. People who desire to own a technology generally expressed a higher level of preference in EVs and PHEVs. The fact that EV was a new technology in 2007, was a motivating factor for the families who purchased hybrid electric vehicles (Heffner et al. 2007). We suggest that the innovativeness aspect of TRI should realistically have a positive relationship with EV adoption.

Table 6
Composite Reliability and Average Variance Extracted for multi-item measurements.

Items	Loading	CR	AVE
Discomfort			
When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do [DIS1]	0.70	0.75	0.43
Technical support lines are not helpful because they do not explain things in the terms I understand [DIS2]	0.63		
Sometimes, I think that technology systems are not designed for use by ordinary people [DIS3]	0.67		
There is no such thing as a manual for a high-tech product or service that is written in plain language [DIS4]	0.62		
Innovativeness			
Other people come to me for advice on new technologies [INN1]	0.68	0.85	0.59
In general, I am among the first in my circle of friends to acquire new technology when it appears [INN2]	0.81		
I can usually figure out new high-tech products and services without help from others [INN3]	0.80		
I keep up with the latest technological developments in my areas of interest [INN4]	0.78		
Optimism			
New technologies contribute to a better quality of life [OPT1]	0.81	0.81	0.52
Technology gives me more freedom of mobility [OPT2]	0.83		
Technology gives people more control over their daily lives [OPT3]	0.68		
Technology makes me more productive in my personal life [OPT4]	0.53		
Insecurity			
People are too dependent on technology to do things for them [INS1]	0.74	0.80	0.51
Too much technology distracts people to the point that it becomes harmful [INS2]	0.75		
Technology lowers the quality of relationships by reducing personal interaction [INS3]	0.76		
I do not feel confident doing business with a place that can only be reached online [INS4]	0.60		
Environmental Values			
It is important to me that the products I use do not harm the environment [ENV1]	0.85	0.94	0.75
I consider the potential environmental impact of my actions when making many of my decisions [ENV2]	0.91		
My purchase habits are affected by my concern for our environment [ENV3]	0.90		
I am concerned about wasting the resources of our planet [ENV4]	0.84		
I would describe myself as environmentally responsible [ENV5]	0.88		
I am willing to be inconvenienced in order to take actions that are more environmentally friendly [ENV6]	0.83		
Desire for Unique Consumer Products (DUCP)			
I am very attracted to rare objects [DUCP1]	0.62	0.87	0.47
I tend to be a fashion leader rather than a fashion follower [DUCP2]	0.63		
I am more likely to buy a product if it is scarce [DUCP3]	0.71		
I would prefer to have things custom made than to have them ready made [DUCP4]	0.70		
I enjoy having things that others do not [DUCP5]	0.72		
I rarely pass up an opportunity to order custom features on the products I buy [DUCP6]	0.73		
I like to try new products and services before others do [DUCP7]	0.74		
I enjoy shopping at stores that carry merchandise that is different and unusual [DUCP8]	0.65		

Table 7
Bivariate Correlations between variables.

	Purchase Cost	Maintenance	Fuel	Convenience	Range	Optimism	Innovativeness	Discomfort	Insecurity	Green Values	DUCP	Willingness to purchase	Willingness to pay higher price
Purchase cost		**0.259****	−0.048	−**0.215****	**0.156****	**0.166****	0.026	−0.009	0.068	−0.062	0.059	−0.089	−0.038
Maintenance	**0.259****		**0.121***	0.023	0.020	−**0.124***	−0.014	**0.109***	−0.088	−0.064	0.079	−0.049	−0.051
Fuel	−0.048	**0.121***		−0.065	−0.014	0.003	−0.011	0.015	**0.191****	−0.054	0.069	−0.192**	−**0.244****
Convenience	−**0.215****	0.023	−0.065		−0.054	−**0.164****	0.081	−0.098	−**0.152****	0.043	−0.006	**0.204****	**0.136***
Range	**0.156****	0.020	−0.014	−0.054		**0.181****	**0.121***	−**0.124***	0.020	−0.076	**0.171****	**0.201****	**0.277****
Optimism	**0.166****	−**0.124***	0.003	−**0.164****	**0.181****		**0.297****	−**0.248****	−0.055	**0.150****	**0.123***	**0.175****	**0.187****
Innovativeness	0.026	−0.014	−0.011	0.081	**0.121***	**0.297****		−**0.324****	−**0.289****	0.031	**0.277****	**0.266****	**0.266****
Discomfort	−0.009	**0.109***	0.015	−0.098	−**0.124***	−**0.248****	−**0.324****		**0.337****	0.065	−0.106	−**0.207****	−**0.196****
Insecurity	0.068	−0.088	**0.191****	−**0.152****	0.020	−0.055	−**0.289****	**0.337****		0.063	−**0.233****	−**0.302****	−**0.214****
Green Values	−0.062	−0.064	−0.054	0.043	−0.076	**0.150****	0.031	0.065	0.063		−0.027	0.103	**0.136***
DUCP	0.059	0.079	0.069	−0.006	**0.171****	**0.123***	**0.277****	−0.106	−**0.233****	−0.027		**0.147****	0.062
Willingness to purchase	−0.089	−0.049	−**0.192****	**0.204****	**0.201****	**0.175****	**0.266****	−**0.207****	−**0.302****	0.103	**0.147****		**0.743****
Willingness to pay higher price	−0.038	−0.051	−**0.244****	**0.136***	**0.277****	**0.187****	**0.266****	−**0.196****	−**0.214****	**0.136***	0.062	**0.743****	

**Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.01 level (2-tailed).

4.3.3. Discomfort and adoption of EVs

Discomfort is in paradox with Optimism, where there is a perceived lack of control over technology and a feeling of being overwhelmed by it (Parasuraman, 2000). In relation to EVs, the perceived inconvenience of adopting the car is an adoption barrier (Jabeen et al., 2012; Javid and Nejat, 2017). Similar to the previous arguments, it is expected that the discomfort dimension of TRI is negatively related to the adoption of EVs.

4.3.4. Insecurity and adoption of EVs

Distrust of technology and scepticism about its ability to work properly is what describes the insecurity dimension. Some people might have a tendency to avoid uncertain situations, and in fact, uncertainty avoidance is an inhibitor of innovation adoption (Singh, 2006). This study expects to find a negative relationship between this dimension of the TRI and the adoption of EVs.

In summary of the above arguments, the following hypotheses are proposed:

H7: Technology readiness of consumers is related to intent to adopt an EV in the way that: (a) optimism and innovativeness are positively and (b) discomfort and insecurity are negatively related to intent to adopt an EV.

4.4. Desire for Unique Consumer Products (DUCP) and adoption of an EV

The need for uniqueness and social status could be key drivers of our purchase behaviour, as some products can represent a state of self-image. The chosen brand and type of car is indeed a way of expressing one's social status and self-image. Consumers would adopt unique products for the purpose of feeling differentiated from others, and stimulating this feeling has been a popular marketing technique (Tian et al., 2001). Self-identity behaviour or symbolic attributes have been established as one of the key drivers of EV adoption intention in studies by Schuitema et al. (2013) and White and Sintov (2017) as an electric vehicle can be congruent with an individual's self-identity. EVs have also been found as a symbol of pride and joy based on a systematic literature review by Rezvani et al. (2015). Heffner et al. (2007) also suggest that adopting an EV could both have a social meaning and personal meanings. The Desire for Unique Consumer Products (DUCP) is a measurement developed by Lynn and Harris (1997) that examines individual differences in the desire for unique consumer products. DUCP is a goal-oriented state, which has three causes: *need for uniqueness, materialism, and status aspiration.* It is expected that buying an EV could also be due to the desire for a unique product, that is not widely used by society currently. Therefore, it is sensible to hypothesise:

H8: Desire for Unique Consumer Products (DUCP) is positively related to the willingness to adopt an EV.

5. Methodology

5.1. Data collection procedure

Data was collected from three cities in the United Kingdom: Bristol, Bath, and Cardiff by randomly approaching people in shopping centres and city centres. Shopping centres that are located in central areas of cities are good for on-site data collection in real time. We also expect that these areas attract people from various nearby locations, which would improve the generalisability of data collection.

These cities were selected mainly due to the convenience of data collection. Cardiff is the capital of Wales, located in the West of the UK, and Bath and Bristol are in the South West of the UK. Table 2 presents the latest data on the adoption rate of EVs in each region of the UK, based on BGL Group, a leading digital distributor of insurance and household financial services.

Paper copies of the questionnaire were given to random participants between September – December 2019. There were no specific criteria in selecting the participants; however, the research assistants used their own judgment with regard to the approachability of participants. For example, mainly those sitting in cafes or who seemed to have been relaxing were approached. This approached helps to minimise the impact of the surrounding environment (i.e. noise, distraction etc.), though it is not a perfect method. The location of data collection sites can be found in Appendix A.

Table 8
Gender and its relationship with EV adoption, DUCP, Green Values, and TRI.

	F	*T*-Value	Sig. (two-tailed)	Note
Overall TRI	0.61	2.42	0.01*	Men scored significantly higher than women.
DUCP	1.69	3.18	0.002**	Men scored significantly higher than women.
Green Values	0.35	0.26	0.79	No significant difference
How likely is it that you will purchase an electric vehicle in the near future?	0.32	0.74	0.46	No significant difference
How likely are you willing to pay a higher price to purchase an electric vehicle compared to a fuel car?	0.17	1.25	0.21	No significant difference

* Significant at 0.05 level.
** Significant at 0.01 level.

Participants completed the questionnaire, with an option to withdraw from the survey at any time, and returned the questionnaire to the research assistants after completion. We set a filtering question in the questionnaire, asking the respondents if they possess a driving license; we excluded the respondents who were not qualified to drive a car. This process resulted in 357 returned surveys, of which 21 had missing data and were removed from the analysis. The total sample size used in this study is 336 (Bath: 155, Cardiff: 61, Bristol:120).

5.2. Measures

To measure **Technology Readiness,** the latest version of TRI (known as TRI 2.0) was used (Parasuraman and Colby, 2015). There are four items for each dimension of TRI that measure Optimism, Innovativeness, Discomfort and Insecurity. The authors of the scale also suggested a formula to calculate the overall technology readiness (TR), which was also used in this research:

TRI 2.0= (Innovativeness + Optimism + (6-Insecurity) + (6-Discomfort))/4

The Green Values scale, developed by Haws et al. (2014), was used to measure the **environmental values**. This 7-point scale has demonstrated a high predictive validity in a number of studies related to environmentally friendly products; it only has six items, which makes it practical to use in a questionnaire.

For instrumental attributes, the questions were borrowed from the work by White and Sintov (2017), which address the aspects in regards to the *perceived purchase cost*, *perceived maintainance costs*, *perceived fuel cost*, *perceived convenience of charging,* and *perceived range*.

Desire for Unique Consumer Products (DUCP) is an eight-item measurement scale developed by Lynn and Harris (1997). Finally, we asked one question for willingness to purchase and one question for willingness to pay a higher price for EV that both represent intent to adopt. All questions and their level of measurement are available in Table 3.

5.3. Participants characteristics

In addition to questions relating to purchasing behaviour, the questionnaire asked the participants their demographic information, age group, and gender- as well as their journey behaviour.

The journey behaviour is inspired from the ACORN Consumer Classification. Acorn is an official segmentation tool used by the UK Government that segments the population based on postcodes. It is a rich dataset that provides detailed analyses on the characteristics of consumers, their demographic data, and social factors. There are six main segments, each of them is broken down into further sub-segments. Table 4 provides brief information on the main six segments and their possible driving behaviour.

More detailed information about each segment can be found on their official website: https://acorn.caci.co.uk/downloads/Acorn-User-guide.pdf.

Table 5 presents a summary of participants' characteristics. The high percentage of 20–29 years olds can be justified by the population pyramid in Bath. (https://www.bathnes.gov.uk/services/your-council-and-democracy/local-research-and-statistics/wiki/population). Since there are only 7 people in the 60 + group, we have combined them with the 50–59 group and created a new group, named 50 +. This will be applied in the ANOVA test later.

6. Results

6.1. Reliability and validity of multi-item measurements

Before testing the hypotheses, all multi-item measurements were examined for their composite reliability (CR) and their item loadings after factor analysis. Table 6 presents the results of factor analysis, composite reliability and average variance extracted (AVE). All measurement scales have met the minimum composite reliability of 0.70, and the AVEs are above 0.5 for all, except for Discomfort and DUCP. As suggested by Fornell & Larcker (1981), the convergent validity can still be met for AVEs below 0.5 if the CR is above 0.6, which is true in our case.

The bivariate correlations between all variables used are also presented in Table 7. This is to ensure that variables have discriminant validity. To do this, the square root of every AVE value belonging to each latent construct should be much larger than any correlation amongst any pair of latent constructs (Zaiţ and Bertea, 2011). Following this procedure, the square root of all AVEs in Table 6 is larger than bivariate correlations between any pair of variables in Table 7. So, we can say that discriminant validity has been met with confidence.

Please note that we do not expect two variables of 'Willingness to Purchase' and 'Willingness to pay higher price' to show discriminant validity because they are two dependent variables that are supposed to capture purchase intention. In fact, these two variables should be highly correlated, which is the case ($r = 0.74$).

6.2. Demographic data and EV adoption

6.2.1. Gender and EV adoption

Our data shows no difference between men and women in their willingness to purchase an EV or pay a higher price for this product.

However, the overall TRI and DUCP are higher amongst men than women, and this difference is statistically significant (Table 8). This shows that overall, men are more willing to embrace new technology and possess new and unique items in general. There is no significant difference for Green Values.

6.2.2. EV purchase intention: Age groups and journey behaviour

ANOVA was used to test whether the age groups and journey behaviour are related to EV purchase intention. There is no significant difference between the age groups for their willingness to purchase or willingness to pay a higher price (Appendix B). The age groups showed no significant difference for DUCP and TRI but surprisingly, there is a significant difference between the 50 + and 20–29 groups in Green Values – The 50 + group expressed a higher level of green values than the 20–29 group (mean difference = 0.54, standard error = 0.16 and p-value = 0.005). In addition, the high mileage drivers are more willing to purchase an EV than city residents using public transport (mean difference = 0.80, standard error = 0.26, p-value = 0.03). Otherwise there is no siginificant difference between other groups (Appendix B).

6.2.3. Participants knowledge of the EV

General public may not have correct perception about basic EV characteristics. In the current market, the purchase cost of electric vehicles is slightly higher but the maintaitances costs are lower than those of comparable ICE (Internal Combustion Engine) cars. Table 9 reveals that majority of participants (around 75 %) perceive the purchase cost of a EV is 'somewhat more' or 'much more' than a standard vehicle. Regarding the maintenance cost of a EV, approximately 10 % of respondents think that this is lower than a standard vehicle; 34 % think that the maintenance cost is the same, and 56 % think that it is somewhat more or much more. The conclusion we can draw is that the participants are not well informed about the maintenance costs of EVs. This result is consistent with a study by Krause et al. (2013), who studied the public knowledge of the Plug-In Electric Vehicles (PEVs) in 21 U.S cities. They reported that majority of people have incorrect perception and knowledge about the PEVs.

6.2.4. Hypotheses testing

A series of multiple regression analysis were conducted between the predictors and intent to adopt variables (willingness to purchase and willingness to pay). The results are available in Table 10, summarised in four regression models. In the first two models, the relationship between instrumental attributes and dimensions of TRI was examined with the intent to purchase variables. In model 3 and model 4, the overall TR 2.0, instead of its four dimensions, was used as an independent variable in order to test the relationship of overall technology readiness with purchase intention variables.

Given the participants' knowledge about each cost element of EVs (Section 6.2.3), it is worth to verify if the above regression models change. First, we selected those 75 % participants who correctly think that EV purchase cost is higher than ICEs and conducted the above four regression models. We observed that purchase and maintenance costs still had negative relationship with willingness to purchase and willingness to pay a higher price.

We also selected those people who correctly think that 'maintenance costs are lower for EVs' but they account for only 10 % of respondents and hence it is not possible to conduct a valid regression model. If we include people who think maintenance costs are the same as for the standard vehicle to this group (though it is not a 100 % correct approach), to increase the sample size to 149 (8 + 27 + 114), purchase and maintenance costs still remain as non-significant factors.

6.2.5. Instrumental values and EV adoption intention

As the results in Table 10 suggest, the perceived driving range and reduction in fuel costs have a significant relationship with purchase intention across all models. Interestingly, the perceived range which an EV could drive is between 20 and 600 miles, with an average of 184.21 miles and a standard deviation of 96.98. The convenience of using and charging the EV also has a strong impact on willingness to purchase, but not on willingness to pay a higher price (model 1 and model 3). There is no statistical support that purchase cost and maintenance cost could drive purchase intention. To conclude, H2 and H3 are rejected; H5 is partially supported. H4 and H6 are also supported.

Table 9
Participants knowledge of EVs.

		Frequency	Percent
I perceive the purchase cost of an Electric Vehicle compared to a standard vehicle is…	Much less	1	0.3 %
	Somewhat less	1	0.3 %
	No difference	81	24.1 %
	Somewhat more	148	44 %
	Much more	105	31.3 %
	Total	336	100 %
I perceive the maintenance cost of an Electric Vehicle compared to a standard vehicle is…	Much less	8	2.4 %
	Somewhat less	27	8 %
	No difference	114	33.9 %
	Somewhat more	126	37.5 %
	Much more	61	18.2 %
	Total	336	100 %

Table 10
Multiple Regression Results for EV purchase intention: Standardised Coefficients.

	Model (1)	Model (2)	Model (3)	Model (4)
	Willingness to purchase	Willingness to pay higher price for EV	Willingness to purchase	Willingness to pay higher price for EV
Purchase cost	−0.09	−0.07	−0.10	−0.07
Maintenance cost	−0.01	0.006	0.007	0.01
Fuel	**−0.14****	**−0.20****	**−0.15****	**−0.20****
Convenience	**0.15****	0.09	**0.15****	0.09
Range	**0.18****	**0.26****	**0.17****	**0.26****
Discomfort	−0.03	−0.05	–	–
Insecurity	**−0.19****	**−0.11***	–	–
Optimism	0.10	0.08	–	–
Innovativeness	**0.11***	**0.15****	–	–
DUCP	0.03	0.04	0.05	0.04
Green Values	0.09	**0.12***	0.09	**0.13****
Overall TR			**0.30****	**0.27****
Constant	**3.43****	**3.36****	**0.74****	**1.34****
R^2	**0.237**	**0.247**	**0.23**	**0.245**

** Significant at 0.01 level.
* Significant at 0.05 level.

6.2.6. *TRI and its impact on EV adoption intention*

As expected, the overall technology readiness (TR 2.0) can predict the purchase intention of EVs (model 3 and model 4 in Table 9). If we inspect each dimension of TRI, we realise that both inhibiting and motivating aspects of technology are drivers of intention to adopt an EV. Insecurity and Innovativeness were found as significant predictors of willingness to purchase and willingness to pay a higher price. But the optimism and discomfort aspects of TRI were not related to purchase intention variables. As a result, there is partial support for H7(a) and H7(b).

6.2.7. *Can environmentalism and DUCP predict EV intention adoption?*

We expected the tendency to value environmental protection to show a strong relationship with the willingness to purchase EVs. However, it only relates to willingness to pay a higher price. In other words, those who are high in green consumption values would be willing to pay a higher price to purchase an EV, as opposed to a fossil fuel car. We would still argue that environmentalism, manifested through green consumer values, is still an important predictor, and hypothesis H1 could partially be accepted.

There is no support for DUCP as an impactful factor on purchase intention, as the regression results show non-significant coefficients across all models. Therefore, H8 is rejected. However, considering Table 7, there is a small positive correlation ($r = 0.14$, $p < 0.01$) between DUCP with purchase intention variables. The non-significant relationship is in contradiction with result by Schuitema et al. (2013), which reported that self-identity has an impact on purchasing an EV. Rezvani et al. (2015) also found 'pride' as one of the predictors of EV purchase. Though the variables used in both studies are not exactly the same as DUCP, they are conceptually highly associated. We could infer that adoption of an EV may no longer be due to a sense of uniqueness, especially with an increasing rate of adoption.

7. Discussion and recommendations

The results of this research highlight important theoretical and managerial implications. Many previous studies recommended the importance of promoting EVs as an environmentally friendly product (Heffner et al.,2007; White and Sintov, 2017; Moons and De Pelsmacker, 2012; Barbarossa et al., 2015; Rezvani et al., 2015). However, the results of this research indicate the greater importance of instrumental attributes and the general trait of people towards technology. The general feeling of insecurity and anxiety towards technology are, in fact, significant barriers towards EV adoption, and this is an important recommendation to policy-makers and marketers. Yet the opposite is also true that innovators, those who would like to embrace new technologies earlier than others, are more willing to purchase an EV. So, the paradoxes, accompanied by a technology, both inhibitors and motivators, are influential in decisions to purchase EVs. Though there was no statistical support for the optimism and discomfort aspects of TRI, overall, this scale is a valid predictor of electric vehicle purchase behaviour. Overall, the following would be recommended to promotors of EVs and policymakers:

(1) Persuading consumers to embrace a revolutionary technology, such as an electric vehicle, is a very challenging task. We would expect more people to drive an electric car in the future, but the importance of educating people on how an electric car works should never be ignored by policy-makers. Considering our survey results, majority of participants in this study perceive EVs to be more expensive than standard cars but only a small percentage are aware that they can save on maintenance costs.
(2) Desire for Unique Consumer Products (DUCP) was not found to be a significant factor in purchasing a EV. This may be a signal that an electric vehicle may no longer be perceived as unique; hence this should be considered in the marketing messages.
(3) It seems that men in general are more willing to embrace new technologies and possess new item, but this does not seem to be the case for the electric vehicles.

(4) The results in this study did not find the purchase and maintenance costs as barriers to purchase, though we should also consider that this research focused on general public perception, rather than those who are actively searching to buy a car. Nevertheles, saving on fuel costs, the convenience of using the car, and driving range are significant drivers in purchasing EVs.
(5) Notably, the perceived driving range is varied highly amongst the respondents in this study, ranging from 20 to 600 miles. This shows that many people do not know about how many miles, on average, an electric car could drive and how long the battery lasts. From a marketing perspective, we recommend highlighting the driving range in communication messages.
(6) Needless to say, improving the convenience of using EVs, such as charging infrastructure, remains a challenge. Findings in this research are in line with Schwanen's (2019) study that due to the small profit margin for private companies in the UK, the development of charging infrastructure has been slow.

8. Conclusion

We need to return to the main research question of this study: what are the drivers of EV purchase intention? Previous studies have investigated the relationship between environmental values and instrumental attributes with the purchase intention of EVs; however, it is worth extending their research by incorporating more behavioural constructs. This study synthesised the Technology Readiness Index with instrumental attributes and environmental values into a prediction model. In addition, the Desire for Unique Selling Products was included in the model; though this trait was found to have a linear relationship with purchase intention, it cannot be considered as a predictor. As a conclusion, this study suggests technology readiness behaviour, measured by TRI, alongside three instrumental values (fuel costs, convenience, and driving range), are the main predictors of EV purchase intention.

9. Limitations and future research

We would also highlight the following limitations in this study and make some recommendations for future research:

(1) This study was conducted in three cities in the United Kingdom, and the results of this study may not be applicable to the entire geographical area.
(2) There are some consistent results with previous studies, such as the importance of some instrumental values and the role of consumer innovativeness. But the role of environmental values is something to explore further. The Green Values scale was used in this study; it would be useful to investigate the role of other measures for environmental values.
(3) In addition, the role of Government incentives to purchase EVs is recommended for further investigation. In the UK, the Government is considering offering free car parking and no charge to enter the congestion zone in London for EVs. At the time of data collection, however, these incentives did not exist; hence it was not included in this research.
(4) Futhermore, the UK Government has recently introduced a new policy that bans the sale of new petrol and diesel cars from 2030 (2035 for hybrid cars). At the time of data collection, such a policy did not exists, so this would be an interesting area to explore in the future.
(5) Purchase intention is not a very accurate way of understanding consumer behaviour. Having mentioned this, the number of studies in this area that used 'purchase intention' is greater than the number of studies which recruited actual adopters or people who experienced driving an EV. This is because the adoption rate of EVs is still low, and hence finding actual adopters is more challenging.
(6) The maintanace cost was not found as a significant factor in this paper. On average, the maintenance costs of an EV is lower than a standard vehicle. However, our results suggest that majority of people are not aware of this. Focusing on active car shoppers in future may provide a clearer picture on how the cost elements of EVs would potentially impact purchase decisions.
(7) Whilst this study tried to categorise journey behaviour using ACORN classification, it may still not have captured all journey behaviours. Future studies could further investigate this and its potential impact on EV adoption.
(8) Whilst there are many advantages with on-site data collection, our sample may entail respondents who were not the residents in those three cities. However, it is not clear whether this could have had any impact on the results.

10. Author statement

The author confirms that there are no copyright issues associated with this paper.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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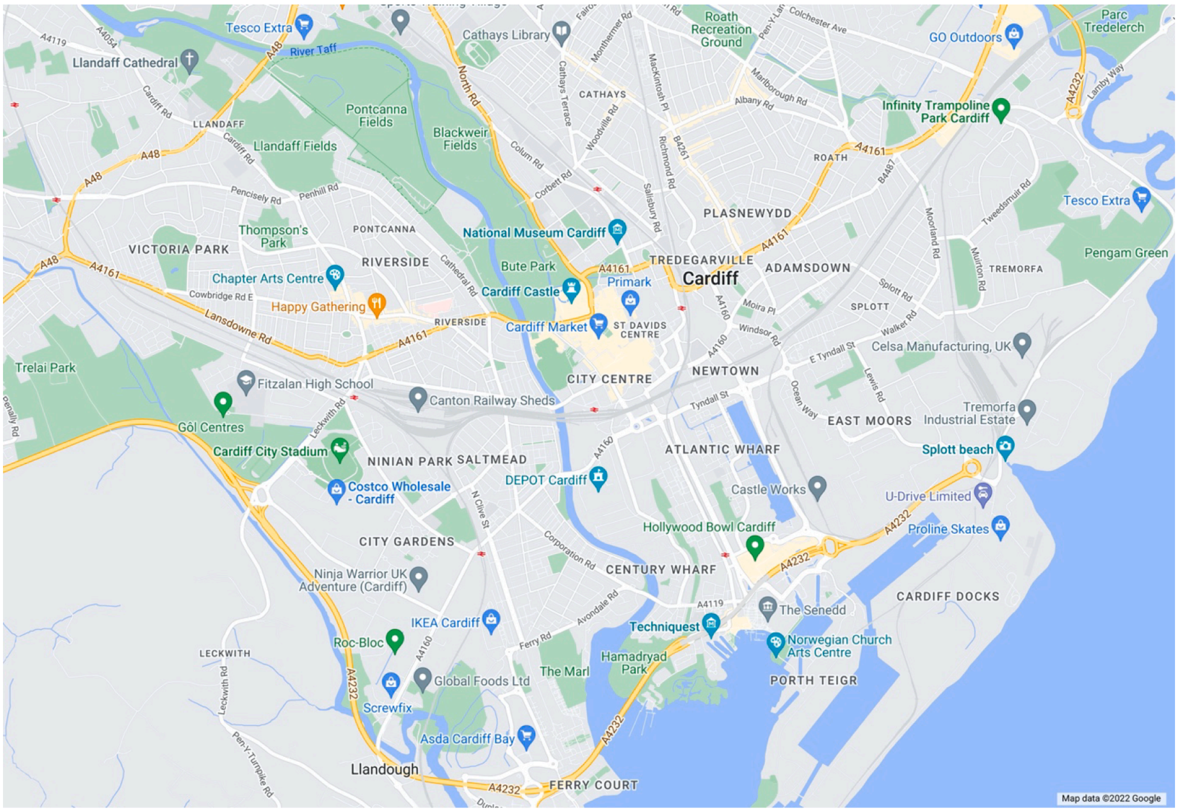
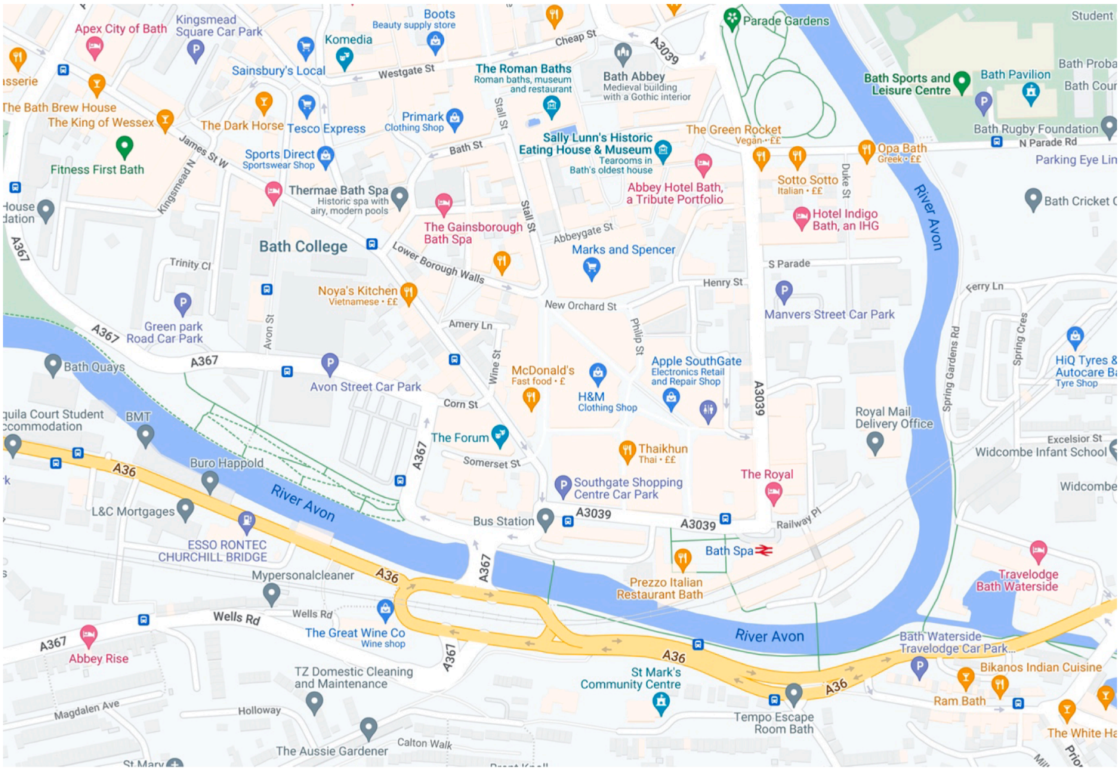
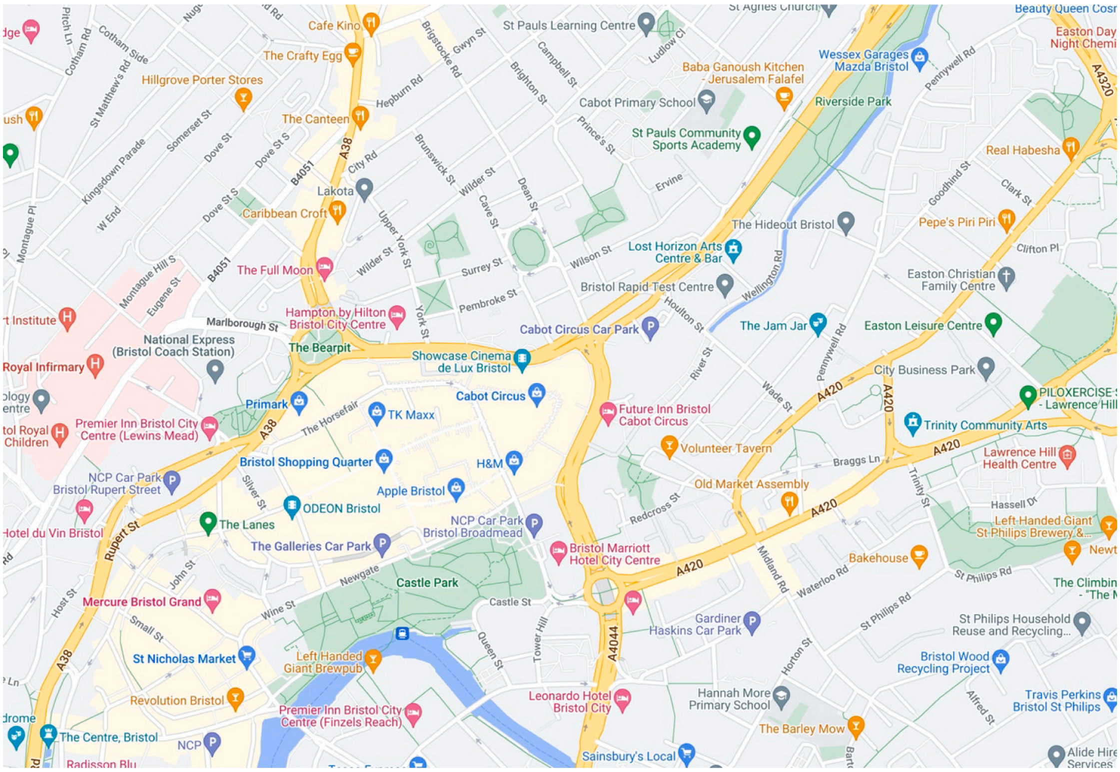
Appendix A. Map of United Kingdom and the location of data collection sites.


Haugesund
Telemarkskanalen Regionalpark
Stavanger
Sandnes
Kristiansand
Inverness
Aberdeen
SCOTLAND
HEBRIDES
Dundee
North Sea
Edinburgh
Glasgow
United Kingdom
Newcastle upon Tyne
NORTHERN IRELAND
Isle of Man
Great Britain
Manchester
Galway
Dublin
Ireland
Liverpool
Sheffield
Limerick
Birmingham
Cambridge
Cork
WALES
ENGLAND
Bristol
Cardiff
London
Southampton
Brighton
Plymouth
English Channel
Guernsey
Jersey
Caen
Celtic Sea
Brest
Paris
Groningen
Bremen
Hamburg
Amsterdam
Hanover
The Hague
Netherlands
Rotterdam
Dortmund
Essen
Antwerp
Düsseldorf
Brussels
Cologne
Lille
Belgium
Frankfurt
Luxembourg
Mannheim
Karlsruhe
Stuttgart
Strasbourg
Jylland
Kiel
Vendsyssel
Aalborg
Aarhus
Map data ©2022 GeoBasis-DE/BKG (©2009), Google


Tesco Extra
River Taff
Llandaff Cathedral
Cathays Library
Roath Recreation Ground
GO Outdoors
Parc Tredelerch
CATHAYS
LLANDAFF
Pontcanna Fields
Llandaff Fields
Blackweir Fields
Infinity Trampoline Park Cardiff
ROATH
PLASNEWYDD
Tesco Extra
Thompson's Park
PONTCANNA
National Museum Cardiff
VICTORIA PARK
RIVERSIDE
Bute Park
TREDEGARVILLE
Cardiff
ADAMSDOWN
TREMORFA
Pengam Green
Chapter Arts Centre
Primark
Cardiff Castle
Happy Gathering
SPLOTT
Cardiff Market
ST DAVIDS CENTRE
RIVERSIDE
Celsa Manufacturing, UK
Trelai Park
CITY CENTRE
NEWTOWN
Fitzalan High School
Canton Railway Sheds
Tremorfa Industrial Estate
Gôl Centres
EAST MOORS
Cardiff City Stadium
ATLANTIC WHARF
Splott beach
NINIAN PARK
SALTMEAD
Costco Wholesale - Cardiff
DEPOT Cardiff
Castle Works
U-Drive Limited
Proline Skates
CITY GARDENS
Hollywood Bowl Cardiff
Ninja Warrior UK Adventure (Cardiff)
CENTURY WHARF
CARDIFF DOCKS
The Senedd
Techniquest
IKEA Cardiff
Norwegian Church Arts Centre
LECKWITH
Roc-Bloc
Hamadryad Park
Global Foods Ltd
The Marl
PORTH TEIGR
Screwfix
Asda Cardiff Bay
Llandough
FERRY COURT
Map data ©2022 Google


Apex City of Bath
Kingsmead Square Car Park
Boots
Komedia
Sainsbury's Local
The Bath Brew House
The King of Wessex
The Dark Horse
Tesco Express
Primark
The Roman Baths
Bath Abbey
Parade Gardens
Bath Sports and Leisure Centre
Bath Pavilion
Bath Rugby Foundation
Fitness First Bath
Sports Direct
Sally Lunn's Historic Eating House & Museum
The Green Rocket
Opa Bath
Sotto Sotto
Thermae Bath Spa
The Gainsborough Bath Spa
Abbey Hotel Bath, a Tribute Portfolio
Hotel Indigo Bath, an IHG
Bath Cricket C
Bath College
Noya's Kitchen
Marks and Spencer
Manvers Street Car Park
Green park Road Car Park
Bath Quays
Avon Street Car Park
McDonald's
H&M
Apple SouthGate
HiQ Tyres & Autocare Ba
Royal Mail Delivery Office
Widcombe Infant School
The Forum
Thaikhun
Buro Happold
Southgate Shopping Centre Car Park
The Royal
L&C Mortgages
River Avon
Bus Station
Bath Spa
ESSO RONTEC CHURCHILL BRIDGE
Mypersonalcleaner
Prezzo Italian Restaurant Bath
Travelodge Bath Waterside
Abbey Rise
The Great Wine Co
St Mark's Community Centre
Bath Waterside Travelodge Car Park
Bikanos Indian Cuisine
Ram Bath
TZ Domestic Cleaning and Maintenance
Tempo Escape Room Bath
The Aussie Gardener
A36
A367
A3039


Cafe Kino
St Pauls Learning Centre
The Crafty Egg
Hillgrove Porter Stores
Baba Ganoush Kitchen - Jerusalem Falafel
Wessex Garages Mazda Bristol
The Canteen
Cabot Primary School
Riverside Park
St Pauls Community Sports Academy
Real Habesha
Lakota
Caribbean Croft
The Hideout Bristol
Pepe's Piri Piri
Lost Horizon Arts Centre & Bar
The Full Moon
Bristol Rapid Test Centre
Easton Christian Family Centre
Hampton by Hilton Bristol City Centre
Cabot Circus Car Park
The Jam Jar
Easton Leisure Centre
National Express (Bristol Coach Station)
The Bearpit
Showcase Cinema de Lux Bristol
Royal Infirmary
City Business Park
Primark
Cabot Circus
TK Maxx
Future Inn Bristol Cabot Circus
Premier Inn Bristol City Centre (Lewins Mead)
Trinity Community Arts
Volunteer Tavern
Lawrence Hill Health Centre
Bristol Shopping Quarter
H&M
NCP Car Park Bristol Rupert Street
Old Market Assembly
Apple Bristol
ODEON Bristol
Left Handed Giant St Philips Brewery &...
The Lanes
NCP Car Park Bristol Broadmead
Hotel du Vin Bristol
The Galleries Car Park
Bristol Marriott Hotel City Centre
Bakehouse
Castle Park
Mercure Bristol Grand
Gardiner Haskins Car Park
St Philips Household Reuse and Recycling...
St Nicholas Market
Left Handed Giant Brewpub
Bristol Wood Recycling Project
Revolution Bristol
Leonardo Hotel Bristol City
Hannah More Primary School
Travis Perkins Bristol St Philips
Premier Inn Bristol City Centre (Finzels Reach)
The Barley Mow
The Centre, Bristol
NCP
Sainsbury's Local
A38
A420
A4044

Appendix B

Journey Behaviour and Willingness to Purchase EV

(I) Which category can best describe your daily journey behaviour?	(J) Which category can best describe your daily journey behaviour?	Mean Difference (I-J)	Sig.
High mileage driver in motorways	Local drivers: Making local mileage driving predominantly	0.140	0.963
	Mainly dependent on friend or family's vehicle for mobility needs	−0.019	1.000
	City resident and using public transport	0.805*	0.032
	Rural rider who uses public transport	0.788	0.448
	Rural rider who uses own car	0.242	0.909
Local drivers: Making local mileage driving predominantly	High mileage driver in motorways	−0.140	0.963
	Mainly dependent on friend or family's vehicle for mobility needs	−0.160	0.998
	City resident and using public transport	0.664	0.110
	Rural rider who uses public transport	0.648	0.652
	Rural rider who uses own car	0.102	0.998
Mainly dependent on friend or family's vehicle for mobility needs	High mileage driver in motorways	0.019	1.000
	Local drivers: Making local mileage driving predominantly	0.160	0.998
	City resident and using public transport	0.824	0.395
	Rural rider who uses public transport	0.808	0.681
	Rural rider who uses own car	0.261	0.988
City resident and using public transport	High mileage driver in motorways	−0.805*	0.032
	Local drivers: Making local mileage driving predominantly	−0.664	0.110
	Mainly dependent on friend or family's vehicle for mobility needs	−0.824	0.395
	Rural rider who uses public transport	−0.016	1.000
	Rural rider who uses own car	−0.563	0.445
Rural rider who uses public transport	High mileage driver in motorways	−0.788	0.448
	Local drivers: Making local mileage driving predominantly	−0.648	0.652
	Mainly dependent on friend or family's vehicle for mobility needs	−0.808	0.681
	City resident and using public transport	0.016	1.000
	Rural rider who uses own car	−0.547	0.839
Rural rider who uses own car	High mileage driver in motorways	−0.242	0.909
	Local drivers: Making local mileage driving predominantly	−0.102	0.998
	Mainly dependent on friend or family's vehicle for mobility needs	−0.261	0.988
	City resident and using public transport	0.563	0.445
	Rural rider who uses public transport	0.547	0.839

Journey Behaviour and Willingness to pay higher price for EVs.

(I) Which category can best describe your daily journey behaviour?	(J) Which category can best describe your daily journey behaviour?	Mean Difference (I-J)	Sig.
High mileage driver in motorways	Local drivers: Making local mileage driving predominantly	0.008	1.000
	Mainly dependent on friend or family's vehicle for mobility needs	0.327	0.949
	City resident and using public transport	0.424	0.562
	Rural rider who uses public transport	0.727	0.496
	Rural rider who uses own car	0.257	0.867
Local drivers: Making local mileage driving predominantly	High mileage driver in motorways	−0.008	1.000
	Mainly dependent on friend or family's vehicle for mobility needs	0.319	0.952
	City resident and using public transport	0.415	0.554
	Rural rider who uses public transport	0.719	0.498
	Rural rider who uses own car	0.249	0.866
Mainly dependent on friend or family's vehicle for mobility needs	High mileage driver in motorways	−0.327	0.949
	Local drivers: Making local mileage driving predominantly	−0.319	0.952
	City resident and using public transport	0.097	1.000
	Rural rider who uses public transport	0.400	0.974
	Rural rider who uses own car	−0.070	1.000
City resident and using public transport	High mileage driver in motorways	−0.424	0.562
	Local drivers: Making local mileage driving predominantly	−0.415	0.554
	Mainly dependent on friend or family's vehicle for mobility needs	−0.097	1.000
	Rural rider who uses public transport	0.303	0.985

(*continued on next page*)

(*continued*)

(I) Which category can best describe your daily journey behaviour?	(J) Which category can best describe your daily journey behaviour?	Mean Difference (I-J)	Sig.
	Rural rider who uses own car	−0.167	0.993
Rural rider who uses public transport	High mileage driver in motorways	−0.727	0.496
	Local drivers: Making local mileage driving predominantly	−0.719	0.498
	Mainly dependent on friend or family's vehicle for mobility needs	−0.400	0.974
	City resident and using public transport	−0.303	0.985
	Rural rider who uses own car	−0.470	0.893
Rural rider who uses own car	High mileage driver in motorways	−0.257	0.867
	Local drivers: Making local mileage driving predominantly	−0.249	0.866
	Mainly dependent on friend or family's vehicle for mobility needs	0.070	1.000
	City resident and using public transport	0.167	0.993
	Rural rider who uses public transport	0.470	0.893

Age Groups and Willingness to Purchase EV.

(I) Age Groups	(J) Age Groups	Mean Difference (I-J)	Sig.
20–29	30–39	0.066	0.984
	40–49	−0.207	0.685
	50+	0.340	0.434
30–39	20–29	−0.066	0.984
	40–49	−0.273	0.565
	50+	0.274	0.681
40–49	20–29	0.207	0.685
	30–39	0.273	0.565
	50+	0.547	0.119
50+	20–29	−0.340	0.434
	30–39	−0.274	0.681
	40–49	−0.547	0.119

Age Groups and Willingness to Pay Higher Price for EV.

(I) Age Groups	(J) Age Groups	Mean Difference (I-J)	Sig.
20–29	30–39	−0.116	0.913
	40–49	−0.056	0.989
	50+	0.487	0.106
30–39	20–29	0.116	0.913
	40–49	0.060	0.991
	50+	0.603*	0.049
40–49	20–29	0.056	0.989
	30–39	−0.060	0.991
	50+	0.543	0.095
50+	20–29	−0.487	0.106
	30–39	−0.603*	0.049
	40–49	−0.543	0.095

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