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A
MASTERS THESIS
On
Barriers to Electric Vehicle Adoption Among Private
Consumers in the United Kingdom: An Integrated TPB–
TAM Framework

A thesis submitted in partial fulfilment of the requirements for the degree of
Masters by Research (MRes) in Management Studies

York ST John University London Campus
September 2026

ABSTRACT

Although the UK government has ambitious targets for battery electric vehicle (BEV) uptake, including the phase-out of new petrol and diesel car sales by 2035, the penetration rate among private consumers is still too low and as of 2023, BEVs only make up approximately 16.5% of the total number of new car sales and approximately 2.5% of the total vehicle fleet. This thesis attempts to bridge this intention–behaviour gap by outlining and testing an integrated model of the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM) with a focus on the barriers to that intention from a psychological, social, technological and structural perspective, using a UK context; a context that, up to this point, has been lacking in this literature, which has largely been based on East Asian contexts and has incorporated integrations of the two models from an architecturally imprecise perspective.

The explanatory sequential mixed methods design was used. The quantitative part involved an online survey ($N = 83$ analytic sample) which examined attitude, subjective norms, perceived behavioural control, perceived usefulness, perceived ease of use, environmental self-identity, cost perceptions and infrastructure/range concerns, and these were analysed using the PROCESS macro for mediation and moderation (Hayes), as well as hierarchical multiple regression. The integrated model accounted for a significant amount of variance in intention to adopt ($R^2 = .55-.61$). The perceived usefulness and the perceived ease of use were the most powerful independent variables, and the perceived ease of use had both direct and partial indirect effects through perceived usefulness in predicting intention. The intention–attitude relationship was positive, but the relationship between attitude and intention appeared suppressed and turned slightly negative and insignificant when other variables were controlled, which was significantly moderated by environmental self-identity which amplified the relationship between attitude and intention. Although there were moderate bivariate associations between intention and subjective norms and perceived behavioural control, both of these measures did not remain significant when added to the multivariate models.

This was followed by a qualitative phase which included semi-structured interviews with five purposively sampled participants, analysed reflexively using a thematic analysis approach, that added considerable depth and, in some instances, nuance to the findings of the quantitative phase. Charging access (availability of off-street parking for home charging) was the most consistently reported barrier across the participants and is interpreted as a structural precondition for adoption as opposed to a purely psychological variable, which helped to explain the lack of significant moderation for perceived behavioural control by housing type.

People's perceptions of ease of use were found to be more about the charging system than the vehicle in and of itself and perceived usefulness was found to be more of a trip-by-trip calculation, weighted toward trips perceived as not suitable to BEV charging. Charging access was not the only structural obstacle that came up, though: cost also rose up on its own, spontaneously, from all participants.

Combining both strands, the study finds that positive attitudes towards EVs are already common among UK private consumers and cannot be considered to be the main barrier to EV adoption on their own. Instead, translating an attitude to an intention is tied to environmental self-identity, and translating intention to viable adoption is tied to structural access to affordable, convenient, (especially at home) charging. The thesis makes theoretical contributions by showing the independent explanatory power of TAM constructs in comparison to TPB constructs, by identifying a boundary condition on the attitude–intention link (environmental self-identity), and by introducing a structural layer (housing type, charging access, affordability) to the psychological adoption models. Practical and policy lessons are the need to focus on home- and kerbside-charging enablement and public-charging interoperability, in addition to further attitudinal campaign efforts, and to leverage identity-congruent over generic environmental messaging. Automated restrictions due to sample size, non-probability sampling and imputed measurement of regional charging density are explored, as well as future avenues of research with larger probability samples and structural equation modelling.

Keywords: Electric vehicle adoption, Theory of Planned Behaviour, Technology Acceptance Model, charging infrastructure, environmental self-identity, mixed methods

ACKNOWLEDGEMENT

I would like to thank my supervisor **Dr Ghulam Mujtaba** for guiding, being patient and criticizing me for this thesis. He played a key role in the creation of the TPB-TAM integrated model and his inputs into the design process using a multi-method approach were truly appreciated.

To the respondents in the survey and particularly the 5 respondents who participated in the interviews for their input and insight into their attitudes and thoughts regarding EV adoption. The qualitative part of this research would not have been possible without their candour which would have provided depth to the statistical results.

Last but not least, I would like to express my gratitude to all people that helped me throughout my stay at **York ST John University (London)/MRes Management Studies** as well as to the university's institutional review board for the directions provided to me on the ethical conduct of this research.

Finally, I would like to express my gratitude to my loved ones who have been around me at all times, supporting, being patient and encouraging. It would not have been possible without them this thesis.

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List of Abbreviations

Abbreviation	Full Term
ATT	Attitude (Toward EV Adoption)
BEV	Battery Electric Vehicle
ESI	Environmental Self-Identity
EV	Electric Vehicle
DoT	Department for Transport
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
ICE / ICEV	Internal Combustion Engine / Internal Combustion Engine Vehicle
INT	Adoption Intention
PBC	Perceived Behavioural Control
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
SMMT	Society of Motor Manufacturers and Traders
SN	Subjective Norms
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
ZEV	Zero Emission Vehicle

Chapter One: Introduction

1.1. Background

In the third decade of the twenty-first century, transport decarbonization in the UK is even more crucial. As of the last emission reporting cycle, the transport sector is the biggest emitter of GHG in the country, with a share of approximately 27 per cent of total domestic GHG emissions, and private passenger vehicles accounting for approximately 55 per cent of the transport sector's carbon dioxide equivalent emissions output (Department for transport [DoT], 2023). The U.K.'s legally mandated target to become a net-zero GHG emission economy by 2050 thus requires an unprecedented and swift transition of the nation's vehicle fleet.

To respond to this call, successive governments have built a more and more ambitious regulatory edifice. The Zero Emission Vehicle mandate, which from 2024 requires manufacturers to progressively increase their annual sales of zero-emission vehicles in the UK, was an operationalization of the announcement of the end of new petrol and diesel car and van sales in 2020, and was subsequently confirmed in HM Government's (2021) Net Zero Strategy to 2035. These regulatory measures have been backed up with fiscal policy measures, such as the previously mentioned Vehicle Excise Duty and congestion charge exemptions, as well as the recently discontinued Plug-in Car Grant, which has created a policy environment specifically aimed at boosting the mass consumer uptake of battery electric vehicles (BEVs).

The overall market reaction to these interventions has been much more muted however, than policymakers had feared. Around 16.5 per cent of new car registrations in the United Kingdom were BEVs in 2023, up from almost zero in 2013 but still below the path needed to reach the 2035 legislation target. Most impressively, the percent of BEVs in the total car fleets on the road is currently about 2.5 per cent (National Grid ESO, 2023; Society of Motor Manufacturers and Traders [SMMT], 2024), with the vast majority of cars on British roads remaining internal combustion engine (ICE) based. This is a very wide chasm between what is said and what is done – at least in terms of consumer behaviour.

This mismatch poses a basic puzzle for researchers on consumer behaviour, transportation policy and technology diffusion. The survey data across all of the United Kingdom is overwhelming in its validation of large numbers of consumers being aware of EVs, broadly positive attitudes towards their environmental aspects, and recognition of the technical capability of modern BEVs (Deloitte, 2023). But there is no obvious link between attitudinal positivity and purchase behaviour at the scale and speed required for decarbonization. The main intellectual impetus for the current research will come from understanding why this intention–

behaviour gap exists, what role psychological, social, technological, and structural factors play in causing it, and how these factors interact with and moderate each other. The focus of this thesis is to show how the shortcomings of the current explanatory approaches can be related to their 'theoretical islanders'.

The two frameworks which have guided empirical research on EV adoption, the Theory of Planned Behaviour (Ajzen, 1991) and the Technology Acceptance Model (Davis, 1989), have each yielded important insights in their own terms, but each is incomplete in some ways that the other can correct. Researchers following the TPB tradition have created ample descriptions of the attitudinal, normative and perceived control factors affecting the intention to adopt BEVs, but they have tended to ignore the cognitive processes that are unique to BEV adoption. TAM researchers, on the other hand, have focused on the critical role of perceived usefulness and ease-of-use and carefully avoided fully accounting for the social and volitional elements that the TPB has always known are crucial to behavioural outcomes. The result is a collection of literature, all of which is larger than the sum of its parts, but no one study yet has provided the theoretically informed, contextually rich narrative required by EV adoption.

Filling this gap by proposing, operationalizing and empirically testing an integrated TPB–TAM framework tailored to the UK socio-technical and institutional context. The study is designed to provide a more comprehensive and nuanced analysis of the barriers to EV adoption than has previously been available, to provide a theory-informed account of how the constructs of these two theories intersect and influence each other in the real world, and to provide a theory-informed account of how these constructs interact and influence each other in policy practice. The integrated model is tested by employing a convergent mixed methods design including both quantitative survey research and structured qualitative research, where both statistical analysis of the relative importance of attitudinal, normative, control-oriented and technology-related perceptions as well as interpretive analysis of the underlying mechanisms of the interaction between these factors to suppress or facilitate adoption intentions among private consumers is conducted.

The thesis therefore makes three contributions, theoretical (showing the explanatory power that could be gained by the principled integration of TPB and TAM in a unified framework); empirical (providing fresh primary data on the barriers UK private consumers face at a key juncture in the nation's decarbonization path); and practical (extrapolating from the empirical data specific, targeted implications for policy instrument design, infrastructure investment and marketing communication aimed at bridging the persistent gap between green intention and EV adoption).

1.2. Problem Statement

The UK Government have committed to phasing out all new petrol and diesel cars and vans from 2035, but this is not happening in the private sector as battery electric vehicles (BEVs) are not getting taken up. Although EVs made up a relatively small percentage of the total car fleet in the UK (Society of Motor Manufacturers and Traders, 2024), their percentage of new car registrations was estimated to be just around 16.5% in 2024. The mismatch cannot be simply attributed to cost and availability of vehicles; there are other psychological, social and technological factors that are not well understood.

The TPB (Ajzen, 1991) and the TAM (Davis, 1989) models have been used in prior studies, but most studies on the TPB and TAM have occurred in East Asian contexts, while a number of studies have added TAM components to TPB instead of including it as two separate models (Lieven, 2015; Zhang et al., 2020); the UK context has received little attention.

The UK has also been facing some distinct challenges; for example, about 40% of all households lack off-street parking to charge at home (Anable et al., 2012), and the Zero Emission Vehicle mandate combined with uneven regional infrastructure and the Zero Emission Vehicle (ZEV) mandate, has increased the barriers to adoption for plug-in cars (National Grid ESO, 2023; SMMT, 2022).

Therefore, the study remains unclear about how attitudes, subjective norms, perceived behavioural control and technology related perceptions will interact with each other to influence the intention to adopt EVs among UK consumers, and how those perceptions will interact with environmental self-identity, income, housing type, and housing location. This study aims to fill that gap by providing an integrated TPB–TAM framework for the UK context.

1.3. Research Question

This study will investigate and analyse the determinants of the willingness to use EV among private sector consumers in the UK using the Theory of Planned Behaviour (TPB) and Technology Acceptance Model (TAM). This study has one main research question and three sub questions:

A. Primary Research Question:

1. How well can an integrated theory of planned behaviour (TPB) and technology acceptance model (TAM) account for factors that hinder private consumers from buying and using EVs in the U.K. and what are the most likely factors to affect their EV adoption intention?

B. Secondary Research Questions:

1. What do attitudes, subjective norms, perceived control over behaviour, perceived usefulness and perceived ease of use mean for the EV adoption intentions of UK private consumers?
2. What socio-demographic characteristics, access to infrastructure, costs perception and self-identity moderate in the relationships between TPB and TAM?
3. What are some of the fundamental experiences and perceptions that create EV adoption challenges for consumers and what are the differences among consumers?

1.4. Research Objectives

The purpose of this study is to examine and explain the factors that prevent the private consumer from adopting EV in the United Kingdom by utilizing the theory of Planned Behaviour and the Technology Acceptance Model as a framework. In order to attain this objective, the following research objectives have been defined:

1. To examine the performance of the integrated TPB–TAM model to explain the obstacles to EVs adoption by private consumers in the United Kingdom and to determine the most influential factors associated with the adoption intentions.
2. To investigate the role of attitudes, subjective norms, PBC, PU and PEOU in the intention to EV adoption by private consumers in the UK.
3. To analyse the impact of EV adoption intention and TPB–TAM factors on environmental self-identity, cost perceptions, charging facilities availability, and demographic factors.
4. To understand consumers experiences and perceptions of barriers to EV uptake and understand differences across segments of UK consumers.
5. To recommend policy makers, manufacturers and other stakeholders to overcome barriers and encourage greater EV uptake in the United Kingdom.

1.5. Significance of the study

The importance of this work lies at both the theoretical and empirical levels, as well as in its applied applications and is a unique and relevant contribution to the academic and policy agendas of the United Kingdom for EV adoption.

Theoretically, the integrated TPB–TAM framework developed here is a substantive improvement of the current literature in consumer behaviour and technology adoption. Although the two frameworks have been known to complement each other as formal efforts to integrate them have been limited and executed quite inconsistently. One of the drawbacks in the literature is the use of TAM constructs, such as perceived usefulness and perceived ease of

use, as substitutes for perceived behavioural control in the TPB model, which Lieven (2015) calls conceptually imprecise and prone to systematic measurement error, and which Zhang et al. (2020) similarly criticize as masking the independent predictive power of technology-specific cognitions. The present study adopts a more architecturally rigorous stance, wherein TPB and TAM constructs are analytically distinct and can interact, mediate, and moderate each other in ways that can be structurally captured by only one of the theories. It responds to calls in the literature for frameworks that allow preservation of internal validities of each constituent theory while indicating how constructs for these theories are related in terms of influencing intention to adopt.

Empirically, the study fills a much-needed gap in the evidence base for the UK and at an analytically critical time. The UK offers a very interesting context for EV adoption research, due to its uniqueness as an environment where the EV market is quite large. The country's ambitions for regulation are also amongst the highest in the industrial world, but face a high degree of structural variation in the potential for EV ownership and experience of EV ownership within the population. For a significant minority, an inability to install charging at home is a significant barrier to adoption, due to the relatively small proportion of homes in the UK with off-street parking, compared with North American and Scandinavian studies that are typically comprised of detached homes. The UK has a relatively low proportion of off-street parking compared with similar studies in North America and Scandinavia, and this makes domestic charging installation unfeasible for a substantial minority of potential adopters.

Further, there is significant geographical variation in the density and quality of public charging provision at regional level, as reported by National Grid ESO (2023), which directly impacts the ease of use and perception of behavioural control. This regional diversity is exacerbated by variations in income distribution, and social geography, which makes the hurdles to a potential EV adopter in rural Northumberland very different in nature and magnitude to those they might encounter in inner London. For valid, generalizable findings, a nationally representative study to explore the moderating effect of these structural conditions on the psychological predictors of adoption intention is not only timely but also necessary.

The practical implications of the research are also very significant. The progressive tightening of the Zero Emission Vehicle mandate beyond 2024, which will require increasing annual ZEV adoption rates, establishes a policy context where granular, barrier-specific evidence can have immediate operational relevance for various stakeholders. Evidence can help policymakers to target specific barriers, particularly which ones are most firmly entrenched and within which consumer groups they are most severe, thus going beyond the blunt instruments of purchase

subsidies and regulatory requirements. A clear empirical description of the relative importance of usefulness and ease of use perceptions can focus the product development efforts and consumer communication strategy for vehicle manufacturers. For charging infrastructure operators and local authorities, the intermediary effect of charging access perceptions may also serve as a basis for prioritization decisions for the investment under current conditions in underserved areas and housing typologies based on a principled approach. In every of these ways, the research aims not only to be descriptive of the problem of slow EV market uptake, but to deliver the differentiated, actionable evidence that is needed by the complexity of the transition.

1.6. Thesis Outline

This thesis is composed of Five chapters that are described as follows:

- Chapter 1: The study is introduced with the background of the study, problem statement, research questions, research objectives, significance of the study and overall framework of the thesis.
- Chapter 2 explores the value of the Theory of Planned Behaviour (TPB) and Technology Acceptance Model (TAM) separately, reviews previous research on bringing together TPB and TAM, adds further barrier and enabler measures (i.e., cost perceptions, charging infrastructure access and environmental self-identity), and outlines the gaps in the literature and the hypotheses and conceptual framework of the study.
- Chapter Three explains the research philosophy, the explanatory sequential mixed methods design, the quantitative phase (survey design), the qualitative phase (semi-structured interviews), integration of the two stages and ethical issues.
- Chapter Four presents the quantitative findings (e.g., data screening, scale reliability, descriptive statistics, hierarchical regression, mediation and moderation analyses, and group comparisons) followed by the qualitative findings, which are presented under eight themes emerging from the thematic analysis of the interview data.
- Chapter Five summarized the thesis and explains the direct and moderation effects in terms of the hypotheses, places the findings in the broader literature, summarizes the theoretical and practical/policy implications, points out limitations, and suggests future research directions.

Chapter Two: Literature Review

The purpose of this chapter is to offer a thorough review and critical evaluation of the existing scholarly literature that has been related to the theoretical and empirical interests. It is organized in 5 parts. The first one reviews the Theory of Planned Behaviour and how it is applied to EV adoption. The second summarizes the Technology Acceptance Model and its modifications in the context of the vehicle technology. The third examines integrative approaches which have tried to reconcile or integrate the two traditions. The fourth looks at the role of other barrier and supporter constructs identified in the EV adoption literature focusing on barrier constructs specific to the UK. The fifth presents the main theoretical gaps which are being filled by the present study and formulates the formal hypotheses that emerge from the review.

2.1. Theory of Planned Behaviour

2.1.1. Theoretical Foundation

The Theory of Planned Behaviour (Ajzen, 1991) is an extension of the Theory of Reasoned Action (Fishbein and Ajzen, 1975) that posited that human behaviour is most immediately mediated by the behavioural intention, which in turn is a function of attitude towards the behaviour and subjective norm. For intention to become behaviour, Ajzen added perceived behavioural control as a third determinant of intention, acknowledging that the volitional aspects of control vary across persons and situations, and that the actual control in terms of enabling conditions and constraining conditions is also a significant predictor of whether intentions will be translated into behaviour.

The TPB includes general attitudes towards a behaviour, which refer to both cognition (beliefs about the behaviour) and affect (feelings about the behaviour) (Ajzen, 1991). Cialdini and Trost (1998) identified two subjective norms, others' expectations (injunctive norms), and others' behaviours (descriptive norms). Perceived behavioural control has two factors, internal factor which refers to the individual's beliefs in his or her ability to perform the behaviour and the external factor which refers to his or her perception of the presence or absence of enabling or disabling environmental conditions.

A large empirical history has been built up within the TPB covering many domains of behaviour. The three TPB constructs are among the best-documented models in social psychology with Armitage and Conner (2001) and Sheeran and Taylor (1999) reporting that these constructs can account for 40 to 50 per cent of the variance in behavioural intention and 19 to 38 per cent of the variance in actual behaviour. It has been used more and more

extensively and productively in the context of pro-environmental and sustainable consumption behaviours.

2.1.2.TPB and Electric Vehicle Adoption

There has been a large and consistent amount of evidence to develop around the application to EV adoption. Rezvani, Jansson and Bodin (2015) performed a systematic review of the literature on EV adoption and found that TPB is the most frequently used and empirically supported theoretical model in the field and that attitudinal predictors, social influence mechanisms and control perceptions were found across studies as the most important factors determining purchase intention.

The UK and international consumers' attitude towards EVs, as measured by attitudinal research, has been generally positive in terms of EV environmental credentials and long-term cost of ownership, but was tempered by concerns about the range of EVs, charging convenience and the acquisition costs of EVs (Egbue and Long, 2012). One of the most consistently identified attitudinal barriers to EV adoption, even among EV-positive consumers, is the range anxiety, as defined by Franke et al. (2015): the fear of the car battery not lasting long enough for the journeys they make or want to take. Importantly, research has shown that range anxiety is not always in line with actual driving habits, meaning it may be a cognitive bias or information gap, instead of a rational assessment of practical limitations (Neubauer and Wood, 2014).

Compared to the attitudinal dimension, the subjective norm dimension has been somewhat less studied in the EV adoption literature, and in the available literature, it has been shown that social influence mechanisms work both via injunctive and descriptive routes. Nayum and Klöckner (2014) showed that descriptive norms, particularly the perception that individuals similar to oneself are using EVs, had more influence on the purchase intention than injunctive norms for Norwegian consumers. The significance of an EV's normative influence might be increased by the influence of visible early adopters within social networks, especially in urban areas where EV uptake is greatest, such as the UK context.

In the EV case, there are a number of conditions that need to be enabled in order to adopt, which differ significantly according to the consumers, and which is why perceived behavioral control has been found to be particularly salient. In their cross-cultural study, Barbarossa et al. (2015) found that internal self-efficacy beliefs (confidence in self in technical and logistical aspects of EV use) and external control perceptions (confidence in the availability of charging infrastructure) had the greatest predictive power for EV adoption intention. Anable et al. (2012)

demonstrated that the external perceived behavioural control dimension is also materially constrained in the UK as nearly 40 per cent of households have no access to off-street parking.

2.2. The Technology Acceptance Model

2.2.1. Theoretical Foundations

Davis (1989) developed the Technology Acceptance Model (TAM), which was later extended by Davis, Bagozzi and Warshaw (1989) to explain the acceptance and rejection of new information technology in information systems. The model's two cognitive beliefs were perceived usefulness (the belief that the individual will benefit from the use of a specific system in terms of job performance or later extensions of the model in terms of everyday life) and perceived ease of use (the belief that the individual will not exert any cognitive and physical strain when using a particular system).

The basic assumption of the TAM is that these two beliefs act as mediators between the system characteristics and the adoption intentions and actual use behaviour. Perceived ease of use is hypothesized to directly influence PUS as a system perceived as easier to use will be perceived as more useful, and it is hypothesized to directly influence AI (Davis, 1989). Later models include additional constructs, including social influence, facilitating conditions and hedonic motivation in the TAM (Venkatesh and Davis, 2000) and TPB (Venkatesh et al., 2003), which further shrinks the space between TAM and TPB.

2.2.2. TAM and Electric Vehicle Adoption

To extend TAM to the context of vehicle technology adoption, the concepts of the TAM need to be translated. Within the field of EV, perceived usefulness refers to the customer's evaluation of the practical advantages of BEVs, such as cost savings on operating an EV compared to an ICEV, contribution to the environment, performance and technological sophistication. Perceived ease of use refers to the consumer's judgments related to the mental and physical effort needed to use the vehicle, to charge the vehicle, to access the public charging network, and to incorporate the technology into their existing mobility practices.

Among population segments with low prior experience with BEV technology, perceived ease of use has proven to be a greater barrier than perceived usefulness, as demonstrated in empirical applications of the TAM to EV adoption (Schuitema et al., 2013). This discovery corresponds to a theoretical model of the technology adoption cycle that Rogers (2003) developed, which identifies complexity that is the extent to which the innovation is hard to understand and handle, as one of the elements that slows down the technology adoption process in the hands of the majority of users. So, the message here is that while EVs need to be truly user-friendly, they

must be made available to be user-friendly, particularly in terms of the message being communicated and a reasonable expectation being created among consumers whose mental models of EV technology may have been formed from an assumption about the early generation of EVs that is no longer true.

There are of course some dimensions of ease-of-use perception that are more likely to be significant in the UK context. The complexity of the process of having domestic charging stations installed can also be a barrier to uptake by consumers, due to the need to assess electrical capacity, coordinate with energy suppliers and physical installation, which can be daunting. Although the public charging network is expanding quickly, there is still geographic unevenness, variability in reliability, and multiple charging standards, payment schemes and membership programs that can result in cognitively demanding user experience (Anable et al., 2012). The optimization of energy tariffs, such as the use of time-of-use tariffs that reduce the cost of charging, adds yet another level of complexity that can be seen as an added burden for consumers who have traditionally found petrol or diesel driving to be a simplistic process.

2.3. Integrative Theoretical Frameworks

2.3.1. The Case for Integration

The justification for integrating the TPB and TAM is that both the frameworks focus on complementary but mutually exclusive factors in the adoption decision. The TPB models the social and volitional aspects of behaviour, which reflect the importance of attitude, social pressure and perceived control on intention, and the TPB is well-validated. The TAM offers a well-developed model of technology-specific cognitive beliefs that influence the decision to adopt a new technical system. When a consumer considers buying a BEV, they make a pro-environmental consumption decision (the type the TPB is designed to explain) and they also make a technology adoption decision (the type the TAM is designed to explain). Thus, an integrated framework which maintains the independent explanatory value of both sets of constructs is theoretically better than either of the frameworks alone.

Venkatesh and Bala (2008) have made a similar argument when building TAM3 by adding social influence factors of the UTAUT model to the TAM model. They found that social influence mechanisms—in the TPB referred to as subjective norm—contributed substantially to technology adoption even after useful and ease-of-use perceptions were taken into account, supporting the hypothesis that these two frameworks cover two different explanatory areas.

2.3.2. Prior Integration Attempts

Some researchers have tried to integrate the TPB and TAM partially or completely in the general field of technology adoption and specifically in the EV adoption literature. Bhattacharjee and Premkumar (2004) proposed a belief revision model which included both attitude-behaviour constructs from TPB and technology cognition constructs from TAM, and found that the two are independent predictors of intention to adopt information technology. Their work was an early example of formal integration, but took place in an information systems context, and missed the specific aspects of durable consumer goods adoption.

Kim, Rasouli and Timmermans (2014) used a hybrid choice model with attitudinal and technological dimensions in an East Asian context, as they discovered the hybrid model explained more variation in EV adoption than single-theory models, and that the effect of EV environmental attitudes on EV adoption intention was moderated by technology ease perceptions. A recent systematic review by Shalu and Pandey (2026), synthesizing 103 empirical studies on EV adoption intention, confirmed that TPB and TAM remain the two most frequently applied theoretical frameworks in this field. However, the review found that research employing these integrated frameworks remains heavily concentrated in a small number of national contexts — principally China and India — underscoring the gap that the present UK-focused study addresses.

But a few flaws have been found in the current integration literature. First, the bulk of integration studies has taken place in an Asian setting, and specifically in China and South Korea where the regulatory framework, consumer culture and infrastructure system are very different to that of the United Kingdom and the vehicle market structure. These results cannot be assumed to be generalizable to a UK context. Secondly, most integration studies have been architecturally imprecise and have defined integration as a subset of the perceived behavioral control constructs, instead of as a separate predictor, making the identification of the independent explanatory contribution of the technology cognition pathway difficult. Thirdly, there has been a lack of systematic incorporation of the moderating role of structural and demographic variables in a few studies, which inhibits their ability to provide consumer-segment specific insights. The current study aims to overcome these three limitations.

2.4. Additional Barrier and Enabler Constructs

2.4.1. Cost Perceptions and Financial Barriers

Perceptions of purchase price and total cost of ownership are always one of the most common EV adoption barriers in UK consumer surveys. As per a Deloitte (2023) report titled the Global

Automotive Consumer Study, 57 per cent of UK consumers who considered buying an EV but did not purchase cited purchase price as the most important challenge and main barrier to EV adoption. It also meant that the UK government's purchase subsidy, the Plug-in Car Grant (worth up to £1,500 for eligible cars) was no longer available as EVs remained much more expensive than their internal combustion engine (ICE) equivalents (SMMT, 2022).

The cost of ownership equation for EVs is complicated and nuanced. EV's can be cost competitive or cost advantageous over the life of the vehicle because of lower fuel costs, reduced maintenance costs and exemption from road tax, especially for high mileage drivers that charge mainly at home at off peak domestic electricity rates (Committee on Climate Change, 2020). Financial risk perception due to the higher upfront acquisition cost, uncertainty in residual value and possible risks involved with battery degradation and replacement, however, can be especially pronounced among middle- and lower-income consumer segments. Many believe the cancellation of the Plug-In Car Grant had a disproportionate effect on the affordability factor for these groups (SMMT, 2022).

2.4.2. Charging Infrastructure Access

Access to charging infrastructure is one of the most theoretically complex variables in the EV adoption literature since it is a physical constraint, a dimension of perceived behavioral control in the TPB model, and a factor of perceived ease of use in the TAM model. The physical size of its charging network has been well documented: National Grid ESO (2023) notes the public charging network density is highly varied between UK regions, with London and the South East faring much better than the North, Midlands, Wales and rural regions. The quality of public charge provision is also subject to various restrictions: For example, surveys have shown that a significant percentage of public charging attempts fail because of equipment failure or network failures (Zap-Map, 2023).

Charging access can be seen in a very different way in the UK, especially when considered in terms of housing. Anable et al. (2012) estimated that around 40 per cent of UK households have no access to off street parking which would allow them to install a domestic charger. This is a skewed profile of people living in urban areas, rented housing or flats and terraced housing, which make up a large proportion of the UK's housing stock. For these consumers, EV purchase is contingent upon the availability of public or workplace charging stations, which provides a very different cost, convenience and range management equation than a consumer with a home charging station.

2.4.3. Environmental Self-Identity

In the attitude-behaviour literature, environmental self-identity, which is the extent to which an individual's self-concept includes environmental values and pro-environmental behaviors, has been shown to be an important moderating variable that enhances the relationship between attitudinal orientation and behavioural intention (Sparks and Shepherd, 1992). Van der Werff, Steg and Keizer (2014) showed that people that had a high environmental self-identity were more likely to commit to pro-environmental behaviours repeatedly within the different domains and less vulnerable to the attitude-intention gap that is common for many environmental behaviours. In an EV adoption context, Barbarossa et al. (2015) found that the effect of environmental attitude on intention was significantly bigger for people with higher scores of self-identity compared to those with lower scores. This discovery offers a glimpse that environmental self-identity acts as a booster in the attitudinal pathway, enhancing the transformation of positive environmental evaluation into adoption intention among people whose environmental sustainability is a central part of their personal identity.

2.5. Identified Theoretical Gaps

There are four main theoretical gaps that the present study will address as identified in the foregoing review. Firstly, there is no formally defined and empirically tested integrated TPB-TAM model for EV adoption in the UK. Second, previous integration efforts have been architecturally ambiguous, meaning that they have confused constructs of the TAM with subconstructs of the TPB, rather than analysing them as separate and distinct predictors. Third, the moderation effects of the structural and demographic factors (housing typology, geographic region and income) have not been examined systematically together with an integrated psychological framework. Fourth, the qualitative pathways by which quantitative barriers were identified in the consumers lived experience have not been explored sufficiently, which has hindered the actionability of the identified barriers in this study to policy and industry audiences.

Such gaps warrant an investigation that develops a formally explicit integrated framework, validates it with a nationally representative sample via a rigorous SEM approach, examines theoretically-driven moderating factors, and deepens the quantitative analysis with the qualitative dimension of semi-structured interviews. Formal hypotheses derived from this review are given in Section 2.6.

2.6. Hypotheses

Based on the theoretical overview presented above, the following five main hypotheses are made:

H1: The relationship between attitude towards electric vehicle (EV) adoption and electric vehicle (EV) adoption intention is positive and significant. This means that the more positive the attitude, the higher the intention to buy/lease an electric vehicle (EV).

H2: It can be stated that intention to adopt EVs is related to subjective norms positively. More precisely, the higher the perceived social pressure from one's important others to adopt EVs, the higher the intention to adopt EVs.

H3: The perceived behavioural control is a positive relationship with EV adoption intention, suggesting that the greater the perceived ability and access to enabling conditions, the greater is the EV adoption intention.

H4: Perceived usefulness of EVs is positively correlated with EV adoption intention, the more positive the perceived usefulness, the greater the EV adoption intention.

H5: Higher perceived ease of use of EVs correlates with higher EV adoption intention as lower perceived cognitive and practical complexity of owning a BEV leads to higher EV adoption intention.

In addition, the following moderation hypotheses are tested as secondary propositions:

HM1: The results indicate that environmental self-identity moderates the relationship between attitude and EV adoption intention, with a stronger effect of attitude on intention for those with high environmental self-identity.

HM2: The positive relationship between perceived behavioural control and EV adoption intention is stronger among consumers with access to off-street parking than among those without it, since external control perceptions are structurally constrained for consumers unable to install home charging.

HM3: There is a moderating effect between perceived ease of use and adoption intention, such that the positive influence of perceived ease of use on intention is stronger for regions with a higher density of public charging infrastructure.

2.7. Conceptual Framework

This chapter introduces the conceptual model, which will be used during the empirical investigation. It starts by outlining the architecture of integrated TPB-TAM framework, explaining the relationship between the constructs of this model and supporting the reasons for hypothesizing each pathway. It then reviews how moderating and mediating variables were

introduced, how each construct was measured, and the possible findings for each on a theoretical basis.

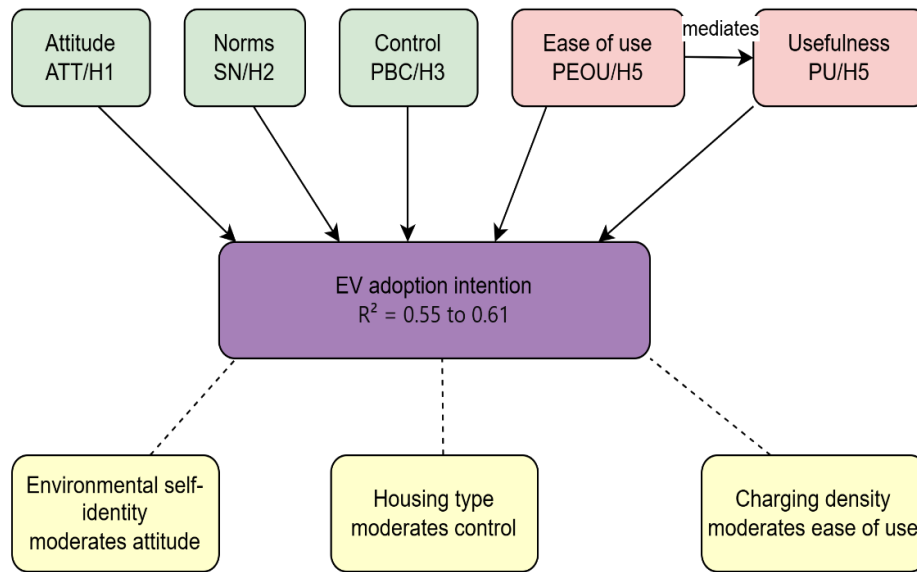


Figure 1: Integrated TPB-TAM Conceptual Framework

2.7.1. Integrated Framework Design

The integrated TPB-TAM framework suggested in the present study conceptualizes the five primary constructs of both sources as separate analytical direct predictors in the model of EV adoption intention. The attitudes toward EV adoption, subjective social norms and perceived behavioural control are adapted from TPB (Ajzen, 1991); perceived usefulness and perceived ease of use are adapted from TAM (Davis, 1989). The framework adopts the same proximal determinant used in the standard TPB-TAM model (adoption intention) and defines the adoption behaviour as an outcome variable measured in terms of self-reported decisions to purchase or lease, since adoption behaviour is considered as a direct consequence of the intention to adopt.

Unlike some previous studies, the perceived ease of use is included as a separate predictor of intent to adopt, rather than as a proposed direct effect on perceived usefulness. This architecture maintains the original specification of the TAM (Davis, 1989), and enables the ease-of-use pathway's independent contribution to be estimated independently of any indirect contribution through the usefulness pathway. The perceived usefulness is also defined as an independent determinant of intention to adopt, rather than as a sub-component of the attitude towards EV ownership that is part of the TPB's attitudinal construct, thus separating the technology-specific utility assessment from the overall attitude towards EV ownership.

In addition, the framework includes a direct positive effect of perceived ease of use on perceived usefulness as proposed by Davis (1989), and that this mediated effect is one pathway by which perceived ease of use becomes perceived usefulness and, thus, adoption intention. The proposed theoretical relationship between perceived behavioural control and perceived ease of use in the TPB and TAM, respectively, is also recognized as an overlap in the construct's contents, as both predict the consumer's assessment of his or her ability to control the demands of EV adoption. These are defined and treated separately in the present study and investigated to determine if they remain discriminant valid in the UK consumer context.

2.7.2. Supplementary Constructs and Moderating Effects

Three sets of supplementary variables are introduced as moderators of the main TPB-TAM pathways in the integrated framework. Environmental self-identity is defined as a moderator of the attitude-intention relationship, which increases the effect of positive attitudinal evaluation on adoption intention for those in whom environmental sustainability plays a key role in their self-concept (van der Werff, Steg and Keizer, 2014). This moderation effect is likely to be especially strong for consumers showing a clear connection between their purchase behaviour and explicit statements of environmental identity in other areas.

The relationship between perceived behavioural control and perceived ease of use and intention is moderated by housing typology and charging access, respectively. The theoretical justification is that relevance of these psychological constructs to adoption decisions will differ depending on the structural constraints consumers face: The consumers with home charging capability will have high perceived behavioural control on most dimensions and their relevance on adoption intentions will be strong; For consumers without home charging access, external control perceptions will be structurally constrained regardless of their psychological disposition, which will in turn attenuate the relationship between external control and intention. Geographic region and the density of charging stations is captured as contextual factors of the ease of use-intention relationship; the relevance of ease-of-use cognitions, and the accuracy of these cognitions, is affected by the practical experience of EV usability, which is influenced by the availability and quality of local charging provision. Consumers in well-served areas might have more first-hand experience of ease of use of public charging and hence be more informed and perhaps more positive on ease of use, while consumers in under-served areas may extrapolate from limited experience or second-hand accounts, which may lead to more negative or uncertain ease of use assessments.

In the full structural model, income is also used as a moderator of the cost perception-intention relationship as well as a demographic control variable. The theoretical prediction is that perceived purchase cost of the BEVs for lower income consumer segments is more likely to deter the intention to buy a BEV than for higher income consumer segments since the financial commitment for purchasing a BEV is more significant for the lower income segments based on their resources.

2.7.3. Measurement Approach

All constructs in the integrated framework are operationalized using multi-item reflective scales in line with the tradition in the TPB and TAM literatures. The scale used for TPB constructs is based on the recommendations of Ajzen (2002) modified for the EV adoption context and UK institutional setting. Scales for measuring TAM constructs are taken from the validated instrument designed by Schuitema et al. (2013) for the EV-specific TAM, which was found to be reliable and valid in both a UK and international setting. The scale developed by van der Werff, Steg and Keizer (2014) is used for measuring environmental self-identity. The cost perception and charging access items are developed specifically for this study, based on the conceptual frameworks provided by Egbue and Long (2012) and Anable et al. (2012), respectively, and then expert reviewed and pilot tested before going to field.

Items are rated on a 7-point Likert scale from strongly disagree to strongly agree. Because this response format offers adequate response variation for the identification of medium-sized effect sizes and because it is similar to the other studies that have used this format, it was chosen. The 7-point format is preferred over the 5-point format for several reasons: more discriminability for SEM applications and increased statistical power (Hair et al., 2019).

Chapter Three: Research Methodology

3.1. Research Philosophy

The approach used in this study is based on a pragmatic philosophy where the epistemological value of a research approach is assessed by its ability to produce knowledge that is useful to understand and solve real world problems (Creswell and Plano Clark, 2018). Pragmatism does not subscribe to the absolute distinction between positivism and interpretivism as philosophies because a more complex social phenomenon, for example, consumer behaviour, often involves both objective measurement of latent psychological constructs and subjective interpretation of lived experience and meaning. This corresponds to the mixed methods design used in this study: quantitative, survey-based methods for testing causal hypotheses regarding the relationships among psychological variables, and qualitative techniques of semi-structured interviews to provide contextually-based accounts of experiential processes underlying statistically identified patterns.

The pragmatist attitude is not that epistemological and ontological positions have no relevance; rather, it is that they must be used as resources for the research endeavour but not as constraining principles. The quantitative aspect of the study has a post-positivist approach whereby the psychological phenomena are considered as real phenomena, which can be measured, though not completely, and that are in causal relationships which can be estimated through statistical methods. The qualitative phase takes a constructivist approach to respondents' accounts of their EV adoption experiences as constructed meanings that are shaped by social context and individual biography and that are not necessarily descriptive, but rather interpretive.

3.2. Research Design

An explanatory sequential mixed-methods design is used; that is, a quantitative phase comes first and is followed by a qualitative phase (Creswell & Plano Clark, 2018). In the quantitative phase, findings emerge regarding the pattern of the relationships between the TPB-TAM constructs which inform the purposive selection of participants in the qualitative interviews and the design of the interview protocol. The qualitative phase is then used to elaborate, contextualize and deepen the understandings of the quantitatively identified patterns.

3.2.1. Quantitative Phase: Survey Design

In order to recruit participants in a way that provides a quantitative sample that reflects diversity across dimensions that were theoretically significant for the purposes of explanation of the study, a stratified sampling approach was designed. The original stratification criteria were

geographic region (nine UK regions), housing type (off-street parking available versus not available, which is considered as an indicator of the feasibility of home charging) and EV experience status (current EV owner, serious considerer, past considerer, non-considerer).

3.2.1.1. Sampling Strategy

The questionnaire was administered online with the survey tool Qualtrics, which allows for forced responses to minimize missing data at the item level and for the export of the completed data sets directly into IBM SPSS Statistics.

Sample size attained can be more finely judged with reference to Green's (1991) two sample-size thresholds for a regression. The achieved sample ($N = 105$) was greater than the required sample size ($N \geq 50 + 8m$), where m is the number of predictors for a formula to test the overall model (R^2). His second formula for the significance of individual predictors is that $N \geq 104 + m$, where N is the number of cases and m is the number of predictors; with the achieved sample of $N = 105$, the number of cases is four short of this second level. It should be noted that this calculation is based on the raw sample of $N = 105$ collected responses rather than the final analytic sample used in the regression models reported in Chapter Four, which was smaller following listwise deletion; the resulting shortfall in achieved power is addressed directly in Section 4.1.4 and as a limitation in Section 5.7. Additionally, to have a clear estimate of the statistical power that was actually available for the regression analysis, a post hoc analysis was conducted using G*Power 3.1 (Faul et al., 2007) for a fixed-model multiple regression with five predictors, with the resulting achieved power reported alongside the regression results presented in Chapter Four; in addition, the marginal shortfall relative to Green's individual-predictor threshold is acknowledged explicitly as a limitation in Chapter five.

3.2.1.2. Survey Instrument

The survey instrument is the same as the original design and has six sections. Section A gathers socio-demographic data such as age, gender, employment status, household income, level of education, geographic location, vehicle ownership history and type of housing. The attitude, subjective norm, perceived behavioural control, perceived usefulness and perceived ease of use (eight items each) scales are the five core TPB-TAM constructs measured in Section B, with each scale being validated. The van der Werff, Steg and Keizer (2014) instrument is used to measure environmental self-identity, which is the focus of Section C. For Section D, the cost perception and charging infrastructure access was assessed with customized items created for this study. EV adoption intention is assessed in section E by 3 items that were adapted from Rezvani, Jansson and Bodin (2015). Section F contains questions about EV experience and

declared factors for non-adoption. The entire instrument was constructed and embedded in Qualtrics and sent out in a distributed link with a built-in logic to randomize the order of the scale items within each construct block, as well as requiring the completion of all items prior to submission, thus minimizing the chance of partial or non-random missing data.

3.2.1.3. Analytical Strategy

Due to the sample size ($n = 105$) being smaller than the minimum recommended for covariance-based SEM (Hair et al., 2019), all quantitative analysis was performed in IBM SPSS Statistics and the PROCESS macro (Hayes, 2018) was used for mediation and moderation. The following five steps were taken:

Data screening. Missing data were analysed and z-scores above +3.29 and below -3.29 (Tabachnick and Fidell, 2013) and normality were checked (skewness/kurtosis).

Reliability and descriptives. Each scale of the instrument was found to have an acceptable reliability score (Cronbach's $\alpha \geq 0.70$, acceptable; Nunnally and Bernstein, 1994), and the average of the items was computed for each of the constructs. The sample was summarized using descriptive statistics.

The direct effects on intention are represented by the H1–H5. Demographic factors were entered first in a hierarchical multiple regression analysis and then attitude, subjective norm, perceived behavioural control, perceived usefulness and perceived ease of use were entered together to predict the intention to adopt. This examines the significant difference between each construct and the intention, which is necessary for H1–H5. The sample size of 105 is sufficient for this model, which is greater than the recommended minimum sample size of $N \geq 104 + m$ predictors by Green (1991).

Mediation (PEOU $\rightarrow$ PU $\rightarrow$ intention). Assessed with PROCESS Model 4, 95% confidence intervals (CIs) were calculated using 5,000 bootstrap resamples to determine if the effect is significant (excluding zero; Preacher and Hayes, 2008).

Moderation (HM1–HM3 and income). Each moderation hypothesis was separately tested using PROCESS Model 1 (Hayes, 2018), with continuous predictor and moderator variables mean-centered before calculating the interaction term of the model (Aiken and West, 1991); the moderation hypotheses were: attitude $\times$ environmental self-identity $\rightarrow$ intention, perceived behavioural control $\times$ housing type (off-street parking: yes/no) $\rightarrow$ intention, and perceived ease of use $\times$ region (high- vs low-density public charging areas) $\rightarrow$ intention. A supplementary model was tested which involved cost perception $\rightarrow$ income $\rightarrow$ intention. Simple slopes analysis was performed to assess the significance of the interactions at each level of the

moderator for categorical moderators and at + 1 SD and – 1 SD of the moderator for continuous moderators.

HM3: perceived ease of use $\times$ region (high- vs low-density charging areas) $\rightarrow$ intention
 Supplementary: cost perception + income $\rightarrow$ intention. Simple slopes were used to examine significant interactions at ± 1 SD of the moderator.

Group comparisons. One-way ANOVA was used to compare adoption intention across the four EV experience status groups, and when variances were unequal, the analysis was followed-up by Welch's ANOVA. The likelihood of Type I error inflation due to multiple testing is recognized because six analytical models are estimated with the same sample (one hierarchical regression model and one mediation model as well as four moderation models and a set of group comparisons). Since this is an exploratory, dissertation-scale study, no formal correction is applied (e.g. Bonferroni), because this would significantly diminish the statistical power for detecting true effects which are already somewhat underpowered with $N = 105$. Rather, the results of mediation and moderation (HM1–HM3 and the additional income model) are presented as exploratory, not confirmatory, and this is explicitly indicated as a limitation in Chapter five.

3.2.2. Qualitative Phase: Semi-Structured Interviews

3.2.2.1. Participant Selection

The quantitative data from the Phase 1 survey was analysed and a purposive sub-sample of respondents to the survey were then invited to take part in semi-structured qualitative interviews. Purposive selection criteria were developed to ensure a maximum variation between respondents with regard to dimensions of theoretical interest as well as to ensure that respondents with quantitative profiles that would help clarify the important relationships found in the regression and moderation analyses were selected. The respondents were selected based on the following criteria: high adoption intention but not adopted; low adoption intention but positive attitude; positive attitude and perceived ease of use scores were different and respondents were distributed across housing type and geographical zone.

3.2.2.2. Interview Protocol and Procedure

Semi-structured interviews were conducted online using video conferencing. With the participants' informed consent, interviews were recorded on audio and transcribed verbatim. The analysis of the transcripts was done through six-step reflexive thematic analysis consisting of the steps familiarization with the data, generating initial codes, identifying themes, reviewing themes, defining and naming themes and writing up the report. In order to ensure

trustworthiness, member-checking was used and reflexivity of researcher was maintained through positionality statement and audit trail.

3.2.3. Integration of Quantitative and Qualitative Strands

The two research strands are integrated during the interpretation phase in the combination display method (Creswell and Plano Clark, 2018). The findings from the quantitative regression analysis, mediation and moderation analysis are summarized in tabular and visual format, while the findings from the qualitative thematic analysis are summarized by narrative. To achieve this, a combined display is created, with a mapping of the qualitative themes onto the quantitative ones identified by the results, so that direct comparisons can be made between the pattern of the results and the experiential richness of the interview accounts.

3.2.4. Ethical Consideration

This study has followed British Psychological Society and the British Sociological Association ethical guidelines and has conducted in accordance with the UK General Data Protection Regulation (UK GDPR). The informed consent signed by each participant makes clear the purpose of research, data collected, how used and stored, ability to withdraw and safeguards in place to ensure confidentiality and anonymity. Data from surveys were anonymized at the time of collection. Transcripts of the interviews were anonymized prior to analysis. Data are accessible to the research team. All data collection activities were submitted to the university's institutional review board for ethical approval.

Chapter Four: Findings

4.1. Quantitative Findings

4.1.1. Data Screening

One hundred and five responses were entered into Qualtrics with one of those being a preview of the survey and 21 being incomplete, or the survey was abandoned when it reached 4% completion, only the demographic items. These were eliminated leaving a valid analytic sample of $N = 83$ completed responses, which corresponds to the item-level response counts ($n = 79-83$) reported in the descriptive summary of the instrument. The missing response rate for the 83 cases retained was very low, and ranged from none to three responses per item, which is typical of a forced-response survey.

To detect multivariate outliers, each of the nine composite construct scores was converted to a standardized (z) value, and the values were screened on an individual case basis. One respondent had a composite z -score higher than the ± 3.29 suggested by Tabachnick and Fidell (2013), indicating that the pattern of responses was “strongly disagree” for all of the scales in the Attitude, Subjective Norms, Perceived Behavioural Control, Perceived Usefulness, and Perceived Ease of Use. This case was not excluded from the primary analysis because of the limited sample size. The skewness values for the nine composite scales ranged from -1.04 to -0.06 , and the excess kurtosis values ranged from -0.68 to 1.79 , with values within the range that is acceptable for parametric analysis (Tabachnick and Fidell, 2013).

4.1.2. Scale Reliability

The internal consistency of each of the nine scales was evaluated with Cronbach's alpha (Table1). Each of these nine scales had an $\alpha \geq 0.70$, a minimum value recommended by Nunnally and Bernstein (1994), and exhibited acceptable to excellent internal consistency, ranging from 0.77 (Cost and Financial Perceptions) to 0.90 (Adoption Intention). Each construct was then collapsed to a composite score by averaging the items within each construct to assess the construct in the subsequent analyses.

Construct	Items	n	Cronbach's α
Attitude (ATT)	4	83	0.848
Subjective Norms (SN)	5	83	0.836
Perceived Behavioural Control (PBC)	6	81	0.871
Perceived Usefulness (PU)	5	82	0.838
Perceived Ease of Use (PEOU)	5	79	0.794
Environmental Self-Identity (ESI)	4	81	0.884

Construct	Items	n	Cronbach's α
Cost and Financial Perceptions (COST)	5	80	0.769
Infrastructure and Range Concerns (INFRA)	5	80	0.771
Adoption Intention (INT)	5	80	0.898

Table 1:Scale Reliability for Study Constructs

4.1.3. Descriptive Statistics

Descriptive statistics for the nine composite constructs are shown in Table 2. Overall, the mean scores indicate that participants' own environmental values and overall attitudes toward EVs were somewhat more positive than their perceived social norms of EV adoption (5.31, SD = 1.21; 5.00, SD = 1.32; compared with 4.43, SD = 1.22, respectively). Adoption Intention (dependent variable) was measured with a mean of 4.76 (SD = 1.28) which placed it slightly above the scale midpoint of 4.

Construct	n	M	SD
Attitude	83	5.00	1.32
Subjective Norms	83	4.43	1.22
Perceived Behavioural Control	81	4.59	1.35
Perceived Usefulness	82	5.08	1.17
Perceived Ease of Use	79	4.67	1.12
Environmental Self-Identity	81	5.31	1.21
Cost and Financial Perceptions	80	4.99	1.02
Infrastructure and Range Concerns	80	5.10	0.92
Adoption Intention (DV)	80	4.76	1.28

Table 2:Descriptive Statistics for Study Constructs (1–7 scale)

The nine constructs are correlated in bivariate correlations shown in Table 3. The bivariate correlations between all five Theory of Planned Behaviour/Technology Acceptance Model (TPB-TAM) predictors and Adoption Intention ($r = 0.49$ to 0.65) indicated that the relationships were hypothesized as positive and moderate-to-strong, which was consistent with the model. Also, the five TPB-TAM predictors had significant correlations with each other ranging from $r = 0.51$ to 0.74 . The pattern of shared variance is important for interpreting the multivariate regression results presented in section 4.1.4.

	ATT	SN	PBC	PU	PEOU	ESI	COST	INFRA	INT
ATT	—	0.69	0.61	0.65	0.58	0.45	0.34	0.02	0.49
SN	0.69	—	0.73	0.58	0.51	0.46	0.19	0.03	0.56
PBC	0.61	0.73	—	0.63	0.57	0.25	0.19	−0.20	0.56

	ATT	SN	PBC	PU	PEOU	ESI	COST	INFRA	INT
PU	0.65	0.58	0.63	—	0.63	0.56	0.48	0.13	0.65
PEOU	0.58	0.51	0.57	0.63	—	0.50	0.47	0.15	0.63
ESI	0.45	0.46	0.25	0.56	0.50	—	0.31	0.27	0.34
COST	0.34	0.19	0.19	0.48	0.47	0.31	—	0.33	0.43
INFRA	0.02	0.03	-0.20	0.13	0.15	0.27	0.33	—	0.14
INT	0.49	0.56	0.56	0.65	0.63	0.34	0.43	0.14	—

Table 3: Bivariate Correlations Among Study Constructs

Note. *n* ranges from 77 to 83 pairwise. ATT = Attitude; SN = Subjective Norms; PBC = Perceived Behavioural Control; PU = Perceived Usefulness; PEOU = Perceived Ease of Use; ESI = Environmental Self-Identity; COST = Cost and Financial Perceptions; INFRA = Infrastructure and Range Concerns; INT = Adoption Intention.

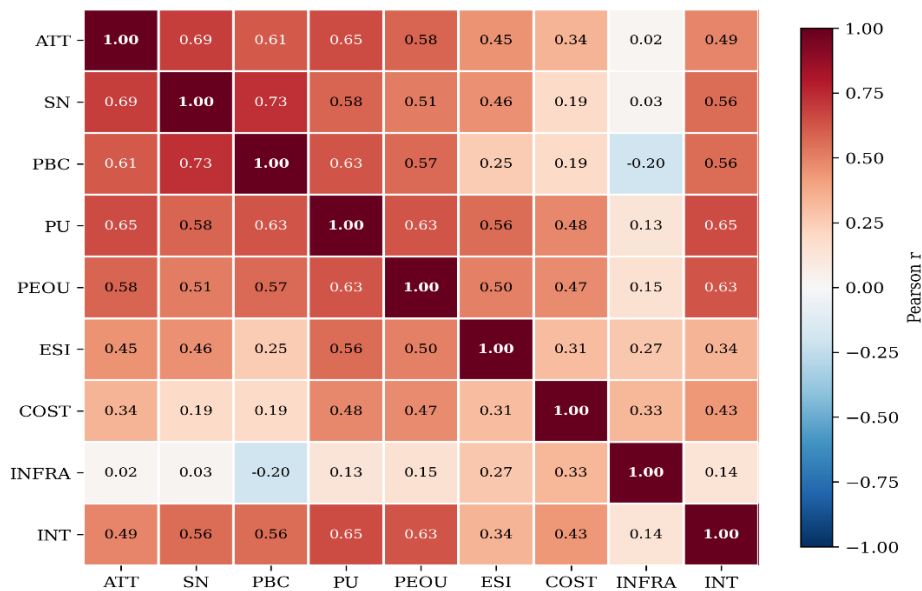


Figure 2: Bivariate Correlations Among Study Constructs

4.1.4. Hierarchical Multiple Regression (H1–H5)

H1 – H5 were tested using a hierarchical multiple regression. The five TPB-TAM constructs (Attitude, Subjective Norms, Perceived Behavioural Control, Perceived Usefulness, and Perceived Ease of Use) were added in Step 2, after demographic controls (age, household income, and off-street parking availability) were added in Step 1.

Listwise deletion across all variables in the full model resulted in $N = 53$, likely due to a high proportion of respondents who answered “prefer not to say” for housing type ($N = 13$) and household income ($N = 12$) that could not be coded for the indicator of off-street-parking. This is a more significant limitation in statistical power than was expected in the sampling design described in Chapter Three, and is addressed in this section as a limitation in Chapter Five. A

robustness check was also performed with a reduced demographic control (age only; $N = 75$) and these models are also reported below, to assess the sensitivity of the results to this sample reduction.

Demographic controls accounted for a small but significant amount of the variance in intention to adopt in the primary model, $R^2 = 0.18$, $F(3, 49) = 3.51$, $p = 0.022$. In Step 2, the addition of the five TPB-TAM predictors produced a significant increase in explained variance, $\Delta R^2 = 0.44$, $\Delta F(5, 44) = 9.91$, $p < 0.001$, with the full model accounting for $R^2 = 0.61$, $F(8, 44) = 8.71$, $p < 0.001$ (adjusted $R^2 = 0.54$). The noncentral F-distribution ($f^2 = 1.13$, $\alpha = 0.05$) calculated to determine post hoc power for the Step 2 predictor block was greater than 0.99.

Predictor	B	SE	β	t	p
Step 1					
Age	-0.12	0.14	-0.09	-0.81	0.420
Household income	-0.53	0.21	-0.32	-2.59	0.013
Off-street parking	0.49	0.28	0.18	1.73	0.090
Step 2					
Attitude (H1)	-0.33	0.15	-0.36	-2.23	0.031
Subjective norms (H2)	0.14	0.17	0.14	0.86	0.395
Perceived behavioural control (H3)	0.29	0.15	0.33	1.88	0.067
Perceived usefulness (H4)	0.28	0.17	0.25	1.64	0.109
Perceived ease of use (H5)	0.34	0.17	0.32	2.08	0.044

Table 4: Hierarchical Regression Predicting Adoption Intention — Primary Model ($N = 53$)

Note. Coefficients for Step 2 predictors are from the full model including Step 1 controls. $R^2 = 0.61$ for the full model; $\Delta R^2 = 0.44$, $p < 0.001$.

Following a check along the robustness lines and using a sample size of 75, the TPB-TAM block once again explains a considerably larger share of variance over and above the age control. In specific terms, it is $\Delta R^2 = 0.46$ and $\Delta F(5, 68) = 13.62$ with p value being less than 0.001. Full model explained $R^2 = 0.55$ with $F(6, 68) = 13.58$ and $p < .001$ value. Within the bigger sample, only Perceived Usefulness ($\beta = 0.37$, $p = 0.006$) and Perceived Ease of Use ($\beta = 0.27$, $p = 0.026$) were significant factors (Attitude wasn't; $\beta = -0.11$, $p = 0.393$).

Predictor	β	t	p
Age (control)	-0.20	-2.39	0.020
Attitude (H1)	-0.11	-0.86	0.393
Subjective norms (H2)	0.16	1.16	0.250
Perceived behavioural control (H3)	0.08	0.62	0.535

Predictor	β	t	p
Perceived usefulness (H4)	0.37	2.86	0.006
Perceived ease of use (H5)	0.27	2.27	0.026

Table 5: Hierarchical Regression Predicting Adoption Intention — Robustness Check, Age-Only Control (N = 75)

As per the findings of Table 3, the bivariate correlation analysis indicated a positive correlation between Attitude and Adoption Intention ($r = 0.49$), which supported the H1 as originally proposed. Therefore, the negative or non-significant coefficient in both multivariate models is the most plausible result of a suppression effect driven by the high correlation values between the other TPB-TAM predictors and the predictor in question ($r = 0.58$ – 0.69). This is supported by the large moderation result as reported in section 4.1.6 (HM1) that the effect of Attitude on Intention is not the same for all subjects but depends on the subject's Environmental Self-Identity. In both model specifications, support was found for Step 1 (H4) and Step 2 (H5). The Step 1 (H1) received qualified support (see above). Steps 3 (H2) and 4 (H3) did not receive support at the multivariate level, but were positively associated with the dependent variable ($r = 0.56$ for both).

4.1.5. Mediation: Perceived Ease of Use → Perceived Usefulness → Adoption Intention

An approach similar to PROCESS Model 4 (Hayes, 2018) was used to assess mediation, where Perceived Ease of Use was entered as the independent variable, Perceived Usefulness as the mediator, and Adoption Intention as the dependent variable (N = 77). In order to know the importance of indirect effect use of 5,000 bootstrap resamples was made using 95% percentile confidence interval (Preacher and Hayes, 2008). Perceived Ease of Use had a positive and significant effect ($a = 0.68$, $p < 0.001$) on Perceived Usefulness, and controlling for Perceived Ease of Use, Perceived Usefulness had a positive and significant effect on Adoption Intention ($b = 0.48$, $p < 0.001$). The indirect effect ($a \times b$) was 0.325, 95% CI [0.138, 0.540], excluding zero, indicating a significant indirect effect. $C' = 0.40$, $p = 0.003$ indicates direct effect when controlling for mediation. Thus, it was partial mediation. The indirect effect of Perceived Ease of Use (PEOU) on Adoption Intention, mediated by Perceived Usefulness (PU), explains approximately 45% of the total effect of Perceived Ease of Use (PEOU) on Adoption Intention ($c = 0.72$, $p < 0.001$).

Path	b	p / 95% CI
a: PEOU → PU	0.681	$p < 0.001$
b: PU → INT (controlling PEOU)	0.477	$p < 0.001$

Path	b	p / 95% CI
c': Direct effect, PEOU → INT (controlling PU)	0.400	p = 0.003
c: Total effect, PEOU → INT	0.725	p < 0.001
Indirect effect (a × b)	0.325	95% CI [0.138, 0.540]

Table 6: Mediation of Perceived Ease of Use on Adoption Intention Through Perceived Usefulness (N = 77)

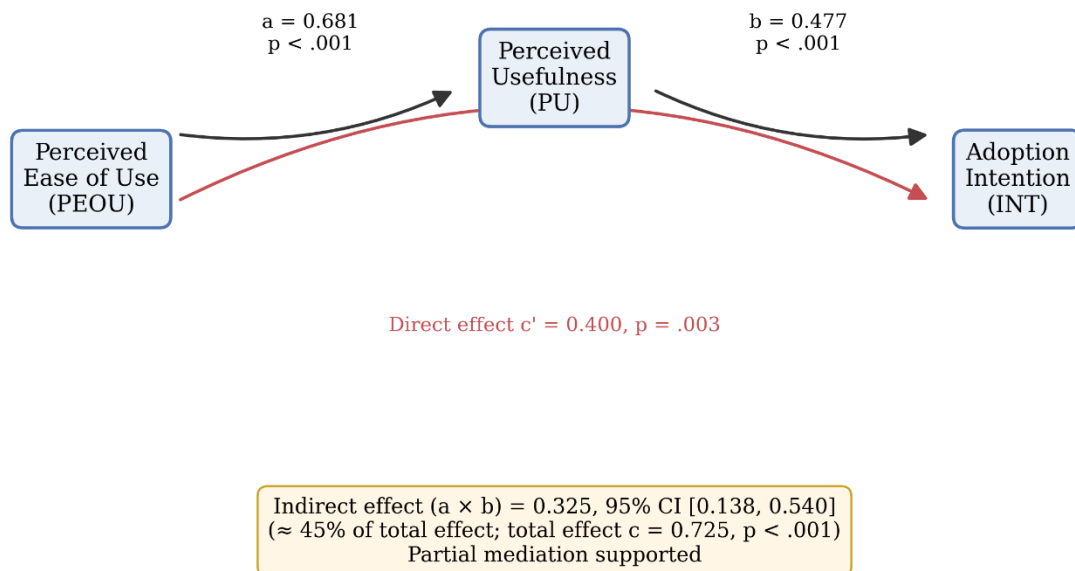


Figure 3: Mediation Model-PEOU → PU → Adoption Intention (N=77)

4.1.6. Moderation Analyses (HM1–HM3 and Supplementary Model)

An analysis similar to the PROCESS Model 1 (Hayes, 2018) was used to test four moderation hypotheses. All continuous predictors and moderators were mean centred, and the interaction term calculated as the product of the two variables (Aiken and West, 1991), while binary moderators were left in their original coding (0/1). Table 7 is a summary of the results.

Hypothesis	Interaction	n	b	p	Result
HM1	Attitude × Environmental Self-Identity	80	0.210	< 0.001	Supported
HM2	PBC × Off-street parking	65	−0.283	0.132	Not supported
HM3	PEOU × Regional charging density	77	0.133	0.642	Not supported
Supp.	Cost perception × Household income	68	−0.034	.866	Not supported

Table 7: Summary of Moderation Analyses

HM1: Attitude $\times$ Environmental Self-Identity. The interaction between Attitude and Environmental Self-Identity significantly predicted Adoption Intention, $b = 0.21$, $p < 0.001$ ($R^2 = 0.40$, $F(3, 76) = 16.60$, $p < 0.001$), supporting HM1.

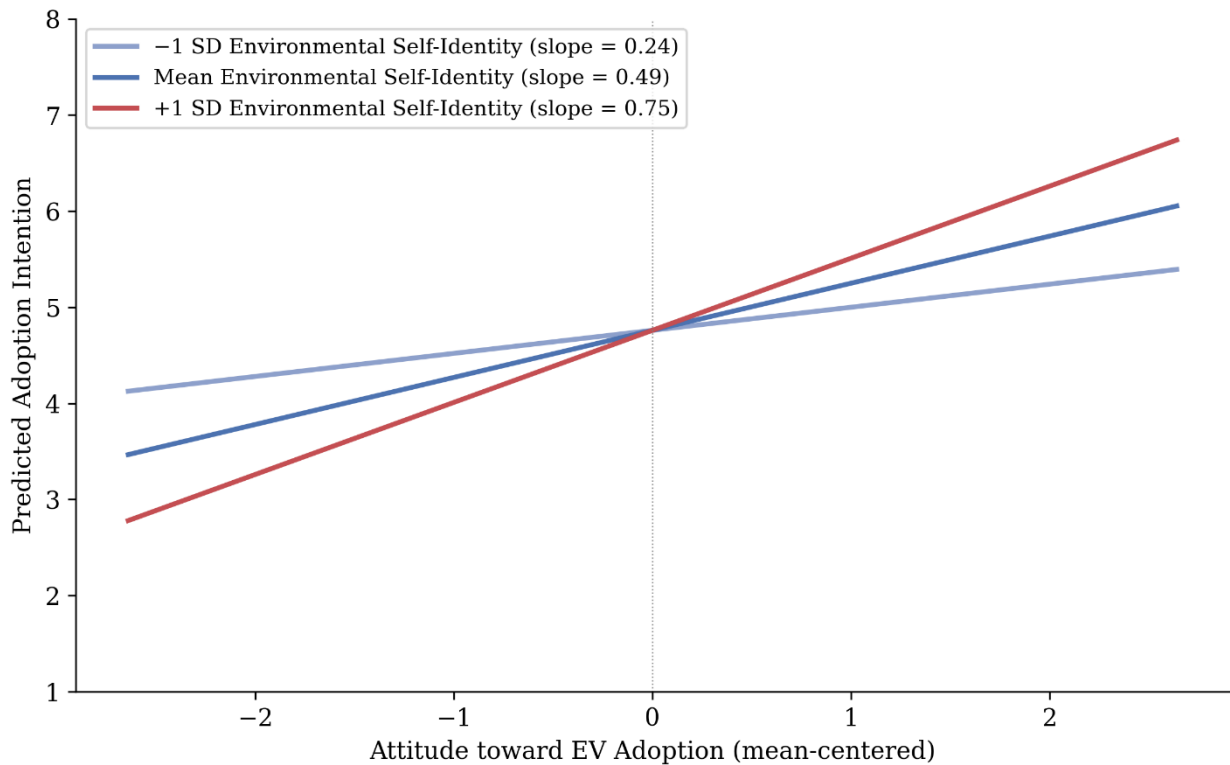


Figure 4: Simple Slopes — Attitude $\times$ Environmental Self-Identity (HM1)

Simple-slopes analysis showed that the positive relationship between Attitude and the Adoption Intention was significant and that it was stronger for higher levels of Environmental Self-Identity: the simple slope values were 0.24 at one standard deviation below the mean of Environmental Self-Identity, 0.49 at the mean, and 0.75 at one SD above the mean. This implies that the translation of Attitude to adoption intention is mainly seen when people have a strong environmental self-identity and explains for the suppression pattern observed for Attitude in section 4.1.4.

HM2: Perceived Behavioural Control $\times$ Off-street Parking. The interaction was not significant, $b = -0.28$, $p = 0.132$ ($N = 65$), and HM2 was not supported.

HM3: Perceived Ease of Use $\times$ Regional Charging Density. The region of residence was mapped as a binary variable, either high density ($n > 100,000$) or low density ($n < 100,000$) public charging provision, using the Department for Transport/Zap map data on public charging provision per 100,000 population. The only two English regions with provision greater than the national average (around 113 devices per 100,000 population as of April 2025) were coded high-density, and the rest of English regions with lower provision were coded low-

density. The interaction was not significant, $b = 0.13$, $p = 0.642$ ($N = 77$), and HM3 was not supported. This classification was not measured directly in the survey instrument, and as such should be considered a methodological limitation when interpreting this null result.

Model: Supplementary Model: Cost Perception $\times$ Household Income. The interaction was not significant, $b = -0.03$, $p = 0.866$ ($N = 68$).

4.1.7. Group Comparisons by EV Experience Status

The results showed that Adoption Intention differed significantly between the four EV experience status groups, so a one-way ANOVA was used to compare these groups (Table 8). A test for homogeneity of variance was carried out, which did not reject the null hypothesis ($W = 2.19$, $p = 0.096$); however, due to the small and unequal sample sizes, Welch's ANOVA was also performed as a robustness check.

Group	n	M	SD
Currently own an EV	8	5.63	0.82
Actively considering buying an EV	19	5.55	0.83
Considered an EV but decided against it	12	4.25	1.07
Have not seriously considered an EV	39	4.35	1.36

Table 8: Adoption Intention by EV Experience Status

EV experience status had a statistically significant and large effect on adoption intention, $F(3, 74) = 6.76$, $p < 0.001$, $\eta^2 = 0.215$; this was corroborated by Welch's ANOVA, $F(3, 25.1) = 8.74$, $p < 0.001$. Tukey HSD post hoc comparisons with active considerers and EV owners both demonstrating significant greater adoption intention than the "considered but rejected" and "not seriously considered" groups ($p < 0.05$), and without significant differences between either group ($p = 0.99$), confirmed by Welch corrected pairwise t-tests. However, this pattern is theoretically expected and is a construct-validity check on the Adoption Intention scale, as the intensity of EV experience was shown to closely follow the intention score.

4.1.8. Summary of Hypothesis Testing

Hypothesis	Result
H1: Attitude $\rightarrow$ Intention	Bivariate support; multivariate suppression (see section 4.1.4)
H2: Subjective Norms $\rightarrow$ Intention	Not supported (multivariate)
H3: Perceived Behavioural Control $\rightarrow$ Intention	Not supported (multivariate)
H4: Perceived Usefulness $\rightarrow$ Intention	Supported

Hypothesis	Result
H5: Perceived Ease of Use → Intention	Supported
Mediation: PEOU → PU → Intention	Supported (partial mediation)
HM1: Attitude × Environmental Self-Identity	Supported
HM2: PBC × Housing/Parking	Not supported
HM3: PEOU × Regional Charging Density	Not supported
Supplementary: Cost × Income	Not supported
Group differences by EV experience status	Significant, large effect

Table 9: Summary of Hypothesis Test Results

4.2. Qualitative Findings

4.2.1. Overview of Participants and Analytic Approach

Purposive selection, following the criteria outlined in Section 3.2.2.1, was used to select the five participants that completed the Phase 1 survey to take part in semi-structured interviews, with the aim of maximizing variation on the factors of: adoption status, adoption intention, housing/parking type, geographical region and public charging density. Four were non-adopters with differing levels of intention (P1, P2, P3, P5) and one had already owned an EV for around two years (P4) so that the barriers set out by non-adopters could be compared to this. Table 10 summarizes the profile of each participant.

ID	Adoption status	Intention	Attitude	PBC	Housing / Parking	Region	ESI	Public charging density
P1	Non-adopter	High (8/10)	Positive	Mod–High	Flat; on-street	London / SE — urban	High	High
P2	Non-adopter	Low–Mod (5–6/10)	Mixed/Mod. positive	Low–Mod	Terraced; on-street	Urban SE England	Moderate	Moderate
P3	Non-adopter	High (8/10)	Positive	Moderate	Flat; on-street	London — urban	High	High (reliability concerns)
P4	Adopter (~2 yrs)	9/10 (post-adoption)	Very positive	High	Detached; driveway + home charger	SW England — semi-rural	Mod–High	Moderate/lower

ID	Adoption status	Intention	Attitude	PBC	Housing / Parking	Region	ESI	Public charging density
P5	Non-adopter	Moderate (6/10)	Mixed/Mod. positive	Mod–Low	Terraced; on-street	NW England — urban	Moderate	Moderate

Table 10:Qualitative Participant Profiles

The six phases reflexive thematic analysis were used to analyse transcripts, as described in Section 3.2.2.2: familiarization with the data, initial coding, searching for themes, revisiting all coded extracts and the full data set with themes, refining and naming themes, and writing the analytic narrative. Coding was deductive and focused on the five key constructs of the TPB–TAM conceptual framework and three moderating variables identified in the conceptual framework (Section 2.7) and open to inductive coding that arose from the participants' own words. This led to eight themes which are presented in brief in Table 11, but described fully below in Sections 4.2.2–4.2.9. To ensure that the interpretation of the participants' accounts is maintained and to adhere to the anonymization procedures outlined in Section 3.2.4, direct quotations have been used throughout.

Theme	TPB–TAM construct(s)	Participants evidencing theme
1. A qualified positive: attitude constrained by practicality	H1 (Attitude)	P1, P2, P3, P4, P5
2. Social norms as reassurance, not persuasion	H2 (Subjective Norms)	P1, P2, P3, P4, P5
3. Charging access as the master condition of perceived control	H3 (Perceived Behavioural Control)	P1, P2, P3, P4, P5
4. Usefulness bounded by the daily/long-journey divide	H4 (Perceived Usefulness)	P1, P2, P3, P4, P5
5. The vehicle is easy; the ecosystem is not	H5 (Perceived Ease of Use)	P1, P2, P3, P4, P5
6. Environmental identity as an amplifier of attitude	HM1 (Attitude × ESI)	P1, P3, P4 (strong); P2, P5 (weak)
7. Housing and parking as the master structural barrier	HM2 (PBC × Housing)	P1, P2, P3, P5 (barrier); P4 (enabler)
8. Public charging density compensates for — but does not replace — home charging	HM3 (PEOU × Charging density)	P1, P3 (density helps); P4 (home charging substitutes for density); P2, P5 (density insufficient)

Table 11:Summary of Qualitative Themes

4.2.2. Theme 1: A Qualified Positive — Attitude Constrained by Practicality (H1)

The attitudes of all five participants towards EVs varied from “moderately positive” to “very positive” and were most frequently based on lower running costs, reduced emissions, quietness

and improving technology. But there was in each narration a spontaneity and an immediate reservation, not an unconditional endorsement.

"I would say moderately positive. I think EVs are a good idea, but I don't think they are necessarily suitable for every person" (P5).

"I would say it is mixed but slightly positive... I don't think they are suitable for everyone yet" (P2).

Even the two participants with the highest attitudes (P1, P3) and the adopter (P4) spoke of a positive evaluation that was not enough to be adopted. P3, who gave an overall rating of 8 out of 10, clearly distinguished between liking EVs and being prepared to purchase an EV:

"If I didn't believe EVs were beneficial, I wouldn't be considering one. The more positive I become about them, the more seriously I think about switching... The main things are the initial price and charging" (P3).

P4, the sole adopter, said she had a positive pre-purchase attitude but said that it was not the attitude, but rather, practical doubts about range and home charging that were the deciding factors: "Having looked at my typical driving habits and how to charge at home made me feel much more confident." This pattern, an always positive rating of EVs that is offset by cost and infrastructure considerations before it becomes an actual plan to buy an EV, provides a somewhat plausible qualitative explanation for the multivariate finding reported in Section 4.1.4, which is that Attitude has a significant negative standardized coefficient when the other TPB–TAM predictors are controlled, despite the positive bivariate correlation with Adoption Intention ($r = 0.49$). The interview data indicate that attitude is a necessary condition to act on EV adoption, rather than a condition on its own — which is consistent with the suppression interpretation provided in Section 4.1.4 and with the moderating role played by environmental self-identity, which will be discussed in Theme 6 (Section 4.2.7).

4.2.3. Theme 2: Social Norms as Reassurance, Not Persuasion (H2)

Across all five accounts, the influence of subjective social norms on adoption intention was a real but clearly secondary influence. The descriptions of positive attitudes by a family member or acquaintance who already owned an EV (descriptive norms) were reported to be more likely to boost personal EV ownership confidence than the general encouragement of EVs. Personal confidence in EV ownership was consistently found to be more strongly affected by first-hand descriptions of positive attitudes of a family member or acquaintance who already owned an EV (a descriptive norm) than by the general encouragement of EVs.

“When someone I know has one and tells me they don't have problems with it, it makes me more confident” (P5).

“I had a colleague who already owned an EV, and they explained how home charging worked and what their experience had been like. That made the idea seem much less risky” (P4).

However, all participants clearly placed social influence as the subordinate issue when requested to compare the importance of the constructs to cost and charging. P3's answer was not unusual – social norms are “helpful, but it's not enough on its own” and charging access and affordability are more decisive. Both P1 and P2 suggested that negative feedback from trusted others would lead to a search for further information or to a postponement of an initial decision, rather than to a change of intention, further supporting the idea that trusted others' feedback has a moderating effect rather than a determining one. While the bivariate correlation with intention was moderate ($r = 0.56$, Table 3), the multivariate regression coefficient for Subjective Norms was not significant ($\beta = 0.14$, $p = .395$) and thus it did not have the power to shape intention independently from other factors that determine it, such as the cost and infrastructure factors, which is in alignment with the previous literature (Nayum & Klöckner, 2014) showing that descriptive norms – seeing other similar people using EVs – are more likely to influence than injunctive norms – being told to use EVs.

4.2.4. Theme 3: Charging Access as the Master Condition of Perceived Behavioural Control (H3)

Access to off-street parking and home charging was the most common and consistent theme across the entire data set, and was the only theme where no participants identified more than one factor as being key: access to off-street parking and home charging.

“It is a significant barrier. If I had a driveway, I could install a charger and charge at home. Without one, I would have to depend on public chargers” (P5).

“It is probably the biggest practical barrier. If I had a driveway, I could install a home charger and charge overnight. Because I don't, I have to depend on public charging” (P3).

“Extremely important. I honestly think it made the decision much easier. I don't have to depend on public charging for normal daily use” (P4).

This theme is supported by the contrast between P4 and the four non-adopters. P4, the only participant who had a private driveway and home charger, had the highest perceived

behavioural control, the highest post adoption intention (9/10) and was the only participant who had adopted. However, in the absence of a driveway, none of the others, regardless of their attitude or intention, described this as taking away “a lot of control” over the timing, cost and reliability of charging, and a number of them explicitly compared this to refuelling a petrol car (“I can just go to a petrol station when I need fuel”, P5). Notably, participants differentiated between internal control (which was very high across all participants) and external control (perception that there will be a place to charge), in accordance with the distinction between self-efficacy and external control perceptions made by Barbarossa et al. (2015), and also following Ajzen's (1991) original bifurcation of the perceived behavioural control construct. This externally-influenced, structure-based factor was by far the strongest constraint on the adoption intention – not a lack of confidence in personal competence.

4.2.5. Theme 4: Usefulness Bounded by the Daily/Long-Journey Divide (H4)

Perceived usefulness to the participants was expressed nearly the same way; EVs were perceived as very suitable and financially beneficial for short frequent trips like commuting and shopping, but this perception decreased significantly for longer and less predictable trips.

“For my normal commuting and shopping, an EV would probably be suitable... That's where I am less certain. I occasionally travel to other parts of the UK, and I don't want to spend a lot of time worrying about where to charge” (P5).

“Most of my journeys are within a reasonable range, so I rarely need to use public chargers during normal weeks” (P4).

Such a split usefulness judgment seemed to be a mental accounting exercise: participants calculated the percentage of their driving that an EV could do well and the percentage that it could not and gave more weight to the latter factor in estimating how useful an EV would be. The strongest bivariate correlation between a predictor and control of any size was with Perceived Usefulness ($r = 0.65$); this factor was also found to have the strongest, and significant, relationship with Adoption Intention in both the primary ($\beta = 0.25$) and robustness-check ($\beta = 0.37$, $p = .006$) regression models (Section 4.1.4), and was consistently identified as the single most valued benefit (“probably reducing my monthly fuel costs”, P5; “I calculated how much I was spending on fuel and compared that with home charging. The potential savings made the EV much more attractive”, P4).

4.2.6. Theme 5: The Vehicle Is Easy; the Ecosystem Is Not (H5)

The ease of use of an EV was consistently rated as positive by all of the participants, while the ease of using the public charging system around an EV was consistently rated as the source of the most complexity.

"I think the car itself would be easy to use. The infrastructure is more complicated... Different companies have different apps and payment systems. Sometimes you have to register before you can use a charger. That seems unnecessarily complicated" (P5).

"The actual charging process seems easy. The difficulty is using the public charging network. There are different operators, apps and payment methods" (P3).

P5 explicitly connected the apparent discrepancy between the positive PEOU rating and only moderate intention to access to charging and the cost of the purchase: "For me, the ease of use is not my biggest problem; my main problem is access to charging and the cost of the purchase of the car – I don't think the car would be difficult to operate." The qualitative pattern is very similar to the quantitative mediation result from Section 4.1.5, in which there was a significant direct effect of Perceived Ease of Use on Adoption Intention ($c' = 0.40$, $p = .003$) and a significant indirect effect through Perceived Usefulness ($ab = 0.325$, 95% CI [0.138, 0.540]), representing about 45 per cent of the total effect. The interview data point to a plausible mechanism for this partial mediation, as when ease of use is linked to the charging ecosystem, in addition to strengthening EV ease of use, it also strengthens intentions, but only once that occurs is the perception of ease of use to translate into intentions. This is in line with the repeated feedback from participants of a one payment and one access system at all public charging stations would significantly boost their confidence and intention (P1, P2, P3, P5).

4.2.7. Theme 6: Environmental Identity as an Amplifier of Attitude (HM1)

Each of the five accounts contained elements of environmental self-identity, and the strength of these accounts and their contribution to attitude to intention was found to be similar to the strong moderation found in Section 4.1.6 ($b = 0.21$, $p < .001$).

While both P1 and P3 had high environmental self-identity and high adoption intention, they described their environmental values as being part of their identity and that they were putting in effort to reinforce the relationship between positive attitude and intention to act:

"I would say it is part of who I am... For me, buying an EV isn't just about saving money. It also feels like a responsible choice" (P3).

“Because I care about the environment, my positive attitude towards EVs has a stronger effect on my intention to buy one” (P1).

P4 shared this opinion of her moderate to high environmental identity as one of several reinforcing motivations, but one that “strengthened my motivation” when the financial and practical case had been made. In contrast, both P2 and P5 rated their environmental self-identity at “moderate” and their environmental concern was “real,” but clearly less important than cost and convenience, and they explicitly speculated that this attitude would be more important if their environmental commitment was greater than that of themselves:

“I think it could, but probably more strongly for someone who is more environmentally conscious than I am” (P2).

The preliminaries findings in Section 4.1.6 that the positive attitudes/Adoption Intention relationship strengthened as Environmental Self-Identity increased (simple slopes of 0.24, 0.49 and 0.75 at -1 SD, the mean, and $+1$ SD respectively) can be explained qualitatively using this graded pattern: from central and motivating sense of self identity (P1 and P3) to reinforcing but secondary (P4) to minor and discountable (P2 and P5).

4.2.8. Theme 7: Housing and Parking as the Master Structural Barrier (HM2)

All non-adopters reported that lack of off-street parking was either “the biggest” or “one of the biggest” barriers to adoption, and all could cite, unaided, the extent to which their desire to adopt would differ if off-street parking were improved.

“Very important. It is probably one of my biggest concerns... I think it would increase quite significantly. Having a home charger would make ownership much easier” (P5).

“Very important. It is probably the biggest disadvantage compared with someone who owns a house with a driveway” (P3).

P5 was here to quantify it directly saying a private driveway would increase her stated intention from 6 to 8 out of 10, while both P1 and P3 said a driveway would make them “definitely” more likely to purchase sooner. The user's side of the equation is confirmed by P4's answer from the other structural position: “wanting an EV and being able to conveniently use one is two different things... if they don't have a driveway, they might not feel capable of owning one. This contrasts with the quantitative moderation result from Section 4.1.6, where the interaction between Perceived Behavioural Control and off-street parking was not significant ($b = -0.28$, $p = .132$, $N = 65$). One plausible interpretation of this apparent paradox is that the level of perceived behavioural control in this sample is not a variable affecting the actual strength of

the relationship between a level of perceived control and the intention to act, but rather the level of perceived control as a direct determinant of the level of perceived control in the first place. One possible interpretation of this apparent paradox is that the level of perceived behavioural control acts as a direct, structural determinant of the level of perceived control, rather than as a variable that alters the strength of the relationship between a given level of perceived control and the intention to act. Participants' experiences always reinforced the perception that parking access is a factor that establishes baseline confidence in the ability to drive and use an EV, rather than changing the intensity of that confidence once it is formed, which would in turn directly impact that intention. This difference between a moderating and a main-effect (or antecedent) role of housing type is mentioned as a candidate explanation to be discussed again in the discussion of HM2 in Chapter Five, which also acknowledges the reduced statistical power of this test ($N = 65$, after listwise deletion) as a limitation (Section 4.1.4).

4.2.9. Theme 8: Public Charging Density Compensates for — but Does Not Replace — Home Charging (HM3)

Participants in the higher public charging density areas (P1 and P3, both London/South East) showed significantly greater confidence that public charging would be viable if they did not have a home charger than did participants in the moderate density areas (P2 and P5).

“There are quite a lot of charging points around London. I can usually find several within a reasonable distance. So, I don't feel completely unable to own an EV” (P3).

“I would say it is moderate. There are charging stations around, but I wouldn't say there are enough to make me completely comfortable” (P2).

But as both P1 and P3 did, they both qualified this confidence by saying they had concerns about the reliability and availability of chargers even in a high-density area, suggesting that density doesn't entirely create a sense of ease of use; the reliability and consistency of access has an impact on ease of use, as well as raw charger count. A further layer was added by P4: this participant said that living in a semi-rural, relatively low-density community, at home charging was a substitute for public charging for her day-to-day life while it only became an issue for longer trips, “for everyday use it doesn't affect me much because I charge at home. But when I travel long distances, I have to plan where to stop.”

Combined, these accounts indicate that public charging density may be a moderator of the relationship between perceived ease of use and overall charging density, since a simple two-way interaction between perceived ease of use and charging density in the

region does not fully account for the relationship. Home charging seems to be a substitute for, not an additive effect with, public charging. This is one possible qualitative explanation for the non-significant HM3 reported in Section 4.1.6 ($b = 0.13$, $p = .642$) besides the above noted limitation of measurement in the survey instrument (regional density was not measured but rather imputed from published statistics). It also suggests a more complex three-way interaction ($PEOU \times \text{regional density} \times \text{home charging access}$) as a possible modification to the moderation model, which is discussed further in Chapter Five.

4.2.10. Cross-Cutting Observations: Cost, and the Divergent Case of P4

Two more patterns traverse the above eight patterns and are briefly commented. First, the cost and financial perception was not one of the five main constructs of the TPB – TAM but was spontaneously mentioned, and repeatedly, by all five participants as a co-equal barrier together with charging access, usually in the same sentence, as in “the main things are the initial price and charging”, P3. This supports the descriptive result that Cost and Financial Perceptions were significantly related to Adoption Intention ($r = 0.43$, Table 3) and is consistent with the finding in Deloitte's (2023) national survey, where 57 per cent of considerers considered Cost to be a key challenge and 65 per cent considered Financial Perceptions a key challenge, and further strengthens the argument developed in Chapter Five that affordability should be interpreted as a structural issue rather than as part of perceived behavioral control.

Second, with P4's case, it is a “natural positive deviant” to which the other four accounts are read. She was also the only participant with a high level of perceived behavioral control (both the driveway charger and home charger were perceived as high), very positive perceived usefulness, and ease of use and with a moderate-to-high level of environmental self-identity, the only participant to match post adoption intention to repeat the behavior (9/10) with the highest level of intention recorded among the non-adopters (P1, P3 8/10). This is consistent with the significant group difference in intention to adopt an EV found in Section 4.1.7 ($F(3, 74) = 6.76$, $p < .001$), in which the respondents who had already owned an EV and the respondents who were actively considering EV adoption scored significantly higher than the respondents who had considered but rejected an EV and the respondents who had not seriously considered the EV, and provides qualitative texture to this quantitative pattern: P4's account suggests that it is the resolution of the perceived-behavioural-control barrier — not a categorically different attitude, usefulness judgement or level of environmental concern — that appears to distinguish her from the non-adopters in this sample.

4.2.11. Summary of Qualitative Findings

The qualitative data aligns with the main story line: Positive attitudes towards the EVs are found throughout the sample, usefulness for daily driving is generally perceived, and the technology of EVs is generally perceived as easy to use, but the intention to use EVs is consistently and specifically limited by the lack of a structural condition (home charging due to lack of off-street parking), which is partially replaced by the density and cost of public charging infrastructure. The translation of positive attitude into intention is strengthened for participants who have a positive attitude as part of their self-concept, because their own environmental self-identity further reinforces the positive attitude to intention. Subjective social norms, however, provide only reassurance and do not motivate participants on their own. The attitudes–ESI interaction pattern offers qualitative support for the pattern of statistical support found for H3, H4, H5 and HM1 in Section 4.1, a plausible (but non-significant) explanation for the counter-intuitive multivariate support for H1, and a clear indication of two specific extensions to the pattern that extend the study and are picked up in the integrated discussion in Chapter Five — a possible main effect of housing type (HM2), and a possible three-way interaction between attitudes, housing type and home charging access (HM3).

Chapter Five: Discussion and Conclusion

5.1. Overview

This chapter discusses the quantitative and qualitative results presented in Chapter Four, in the context of the integrated Theory of Planned Behaviour – Technology Acceptance Model (TPB – TAM) framework outlined in Chapter Two, and the overall implications of the evidence base for theory, policy and practice. The hypotheses of the study are organized into the chapter. The direct-effects hypotheses (H1–H5) are discussed in Section 5.2, the moderation hypotheses (HM1–HM3) and the supplementary income model are discussed in Section 5.3, the quantitative and qualitative strands are presented together in Section 5.4, the theoretical contributions of the study are discussed in Section 5.5, practical and policy implications are discussed in Section 5.6, limitations of the study are discussed in Section 5.7, directions for future research are discussed in Section 5.8, and the overall conclusion is presented in Section 5.9.

5.2. Discussion of Direct Effects (H1–H5)

5.2.1. Attitude and the Suppression Effect (H1)

H1 stated that there is a positive correlation between attitude and intention to adopt. The bivariate correlation was in the appropriate direction ($r = 0.49$) but when the other four predictors of the TPB-TAM model were introduced in the second step of the hierarchical regression, Attitude was negatively related and became significant ($\beta = -0.36$, $p = 0.031$, $N = 53$), and was not significant and remained negative in the age-only robustness check ($\beta = -0.11$, $p = 0.393$, $N = 75$). It is well established that the coefficient's change in sign from the bivariate to multivariate level is the textbook example of a negative effect caused by statistical suppression, not by a negative attitude toward adoption. Attitude correlated highly with each other variable, once the other variables were held constant ($r = 0.58$ - 0.69 , Table 3), and it is this common variance, most likely its shared variance with the other two constructs in the model, Subjective Norms and Perceived Behavioural Control, that appears to be absorbing Attitude's explanatory contribution once the other two variables are held constant.

The moderation result for HM1 (Section 4.1.6) is a more substantive answer than a purely statistical answer. The interaction between Attitude and Environmental Self-Identity was strong ($b = 0.21$; $p < 0.001$), and the simple-slopes analysis revealed that the relationship between Attitude and Intention was weak at low levels of Environmental Self-Identity (slope = 0.24), moderate at the mean (0.49), and strong at high levels of Environmental Self-Identity (0.75). That is, a positive attitude towards EVs translates into intention primarily for consumers

who value the environment as part of their identities, but not for consumers who value the environment primarily for instrumental reasons. These findings are supported by the qualitative data in detail. Participants with high responses on Environmental Self-Identity explicitly mentioned that their positive attitude towards EVs resulted in a stronger intention to purchase an EV due to the meaning of EV ownership for them (as a self-identity of the participant) ("because I care about the environment, my positive attitude towards EVs has a stronger effect on my intention to buy one", P1 and P3). In contrast, both P2 and P5 were moderate on Environmental Self-Identity, and both reported having a positive attitude that was nevertheless limited by practicality and that was not, in itself, a motivator of attitudes, but both explicitly speculated that the attitude would be more important to an environmentally more committed person than it would be to them. The quantitative suppression finding, together with the qualitative theme (Theme 1 and Theme 6, in Sections 4.2.2 and 4.2.7), suggests the same overarching story: attitude is a conditionally necessary but not unconditionally sufficient predictor for the translation to intention, which depends on the extent to which environmental values are self-relevant.

5.2.2. Subjective Norms (H2)

Multivariate support for H2 was not found. At the bivariate level, the subjective Norms correlated with Adoption Intention moderately ($r = 0.56$), but did not show a significant independent effect after controlling the other predictors ($\beta = 0.14$, $p = 0.395$). This aligns reasonably well with the rest of the literature regarding the relative strength of subjective norms when compared to attitudinal and control-related constructs in predicting EV adoption intention (Rezvani, Jansson and Bodin, 2015). The qualitative data is used to explain the mechanism of this pattern, rather than just verifying it. Social influence was indicated in all five interviews (Theme 2, Section 4.2.3) primarily through descriptive norms, by seeing or hearing about an EV owned by someone else similar to the individual, and as a function that typically reassured, rather than persuaded or pressured, to decrease perceived risk, and did not influence intention when it was already present. The participants were clear that they considered the experience of trusted others along with cost and charging access and that the last two factors were the primary ones in the decision-making process. It is consistent with Nayum and Klöckner (2014) who found that descriptive norms were more important than injunctive norms in the context of buying vehicles, and indicates that subjective norms act as an input to some other, more powerful constructs in the EV domain, namely Perceived Behavioural Control and Perceived Usefulness.

5.2.3. Perceived Behavioural Control (H3)

While H3 demonstrated a moderate association with intention at the bivariate correlation level ($r = 0.56$), it failed to achieve significance at the multivariate regression level ($\beta = 0.33$, $p = 0.067$; and $\beta = 0.08$, $p = 0.535$ at the primary model and robustness check). The lack of results is perhaps the most theoretically interesting outcome of this study, as it does not indicate that perceived behavioural control is not relevant to EV adoption; rather it shows it is relevant and was nominated as the single most consistently cited barrier by all five participants (Theme 3, Section 4.2.4) in the interviews. A more likely answer is architectural. In this sample, PBC had a significant correlation with Subjective Norms ($r = 0.73$) and Attitude ($r = 0.61$), indicating that PBC was not simply a gradable perception of how easy it would be for any individual with a specific housing situation to park and charge at home, but more a structural characteristic of the housing situation, which is largely predetermined by housing type. The only adopter and the only participant who has a private driveway with a home charger had very high PBC and the highest recorded attitude (9/10) and all four non-adopters, irrespective of their attitude or environmental identity, perceived that the lack of a driveway removes a considerable amount of control over the cost, timing and reliability of charging, which is similar to the lack of control that they feel over the cost, timing and reliability of refuelling a petrol car. This separation between control as a psychological variable that can be meaningfully partial out by a regression and control as a structural precondition that cannot be fully captured by a regression coefficient once the variance due to housing has been accounted for by the correlations among constructs is elaborated upon in Section 5.3.2, in relation to HM2.

5.2.4. Perceived Usefulness (H4)

H4 was supported. Perceived Usefulness had the highest bivariate correlation with Adoption Intention ($r = 0.65$), and was a significant predictor in the robustness-check model ($\beta = 0.37$, $p = 0.006$), just shy of conventional significance in the smaller primary model ($\beta = 0.25$, $p = 0.109$). This qualitative dimension helps to substantively interpret this quantitative power. There was a clear distinction between the shorter, more predictable journeys, such as in the school run, commuting, shopping, and longer or less predictable journeys; usefulness judgements were more positive in the former, less positive in the latter (Theme 4, Section 4.2.5). The benefit of running-cost savings was the most frequently stated benefit, spontaneously, by both the non-adopter and the adopter in the sample. This consistency indicates that UK consumers are not making one usefulness judgement for EVs, but rather

making a decision on the proportion of their driving in/out of the EV's comfort zone, which is specific to the case of a trip-contingent durable good whose usefulness varies from trip to trip.

5.2.5. Perceived Ease of Use, and Mediation via Perceived Usefulness (H5)

The mediation analysis (Section 4.1.5) revealed that Perceived Ease of Use had a significant direct effect on Adoption Intention ($c' = 0.40$, $p = 0.003$) and a significant indirect effect through Perceived Usefulness ($ab = 0.325$, 95% CI = [0.138, 0.540]), which accounted for approximately 45 per cent of the total effect, consistent with the original TAM specification proposed by Davis (1989). Qualitative data provide a vivid description of the meaning of "ease of use" in this context; it is not the meaning suggested by a naive interpretation of the construct. The usability of the vehicle itself, driving the vehicle, and understanding how to operate the controls were consistently rated as easy to use for all participants, while the challenges they identified were mainly related to the surrounding charging environment (Theme 5, Section 4.2.6): multiple charging operators, incompatible applications and payment systems, and requirements for registration prior to use of a charger. The statistical mediation link is nearly identical to P5's own: cost and charging access were her "biggest problems" while ease of use was not. This is coherent with a reading of the ecosystem level friction captured by Perceived Ease of Use as operating on intention in part by influencing the perceived usefulness of the EV for the individual's driving pattern and a residual direct channel for the ecosystem level friction. The practical implication of this is that we are shifting ease of use for EVs from the vehicle usability, which consumers are already confident on, to the charging network usability where there is a challenge to resolve the friction.

5.3. Discussion of Moderation Effects (HM1–HM3) and the Supplementary Model

5.3.1. HM1: Environmental Self-Identity as Amplifier

More than a single finding, as argued in Section 5.2.1, HM1 was strongly supported and is the most coherent single finding in the study: the environmental self-identity is not a separate driver of intention, but a gain control on the attitude–intention pathway. Consumers with an environmental values identity that is more central to their identity convert positive EV attitudes into purchase intentions efficiently even though consumers with a more peripheral environmental identity do not, even if their stated attitude toward EVs is equally positive. This has implications for the interpretation of EV "positivity" attitudinal survey data by the policy maker or manufacturer, as discussed in Section 5.6.

5.3.2. HM2: Perceived Behavioural Control and Housing Type

The moderation of the Perceived Behavioural Control–Intention relationship by off-street parking availability was not supported ($b = -0.28$, $p = 0.132$, $N = 65$), and the loss of statistical power in this test following listwise deletion ($N = 65$ of 83 , primarily due to non-disclosure of income and housing type; Section 4.1.4) must be interpreted with caution. On the other hand, and rather surprisingly, the qualitative information appears to provide an explanatory account of the null findings that is both specific and theoretically informative, and not just a simple power account. The housing type was the main reason cited when non-adopters were asked what they considered to be the biggest obstacle to having an EV comfortably and they did so in terms of a baseline condition, rather than an intensifying or a diminishing factor in an already established psychological relationship. P4's viewpoint from the other structural position confirmed this, stating that the tech of the home charger and driveway did not make her more likely to intend to use it, but it lifted the barrier that would otherwise have prevented her from intending to use it at all. This is similar to the pattern found for housing type as a direct, largely deterministic antecedent of Perceived Behavioural Control, as opposed to a moderator of the control–intention relationship in the classical sense as a product of the PROCESS Model 1. If the relationship between Control and Intention is already strong across the range of control levels a consumer can occupy, but the level of control itself is limited by Housing Type, then a moderation model (whether or not the slope of the Control-on-Intention is different by Housing Type) would not be well specified to detect this kind of ceiling effect, and a model predicting the level of Perceived Behavioural Control directly by Housing Type is proposed as a modification for future quantitative work (Section 5.8).

5.3.3. HM3: Perceived Ease of Use and Regional Charging Density

With the HM3, no support was found ($b = 0.13$, $p = 0.642$, $N = 77$) and two explanations arise from the overall evidence. The first is measurement-related, with charging density never being directly recorded in the survey instrument, instead being imputed from published census statistics from the Department for Transport and the Zap-Map service at a coarse level of binary (high or low density) and this is likely to have resulted in significant measurement error (particularly when compared to the actual charging density a respondent may have experienced locally). The second explanation is substantive, and connected to Theme 8 (Section 4.2.9). Participants in higher-density areas (P1, P3) did express higher levels of confidence that public charging would be viable if people did not have chargers at home, but qualified this confidence with concerns about the reliability of the chargers, indicating that density of chargers is a poor

proxy for the construct of charging-access, which actually influences ease-of-use perceptions. As importantly, home charging appeared to be replacing public charging density, not adding to it, as she suggested it was not relevant for her routine trips—it was only relevant for longer trips where density (and its lack) was unimportant. This means that the real interaction might be a three-way, not a two-way, interaction: $PEU \times \text{regional charging density} \times \text{home-charging access}$; the moderating effect of regional charging density on PEU is only clearly evident among consumers with no home charging. A simple two-way interaction as tested in HM3 would be expected to be an average of both of these structurally different populations, and could reasonably obscure a true interaction. In Section 5.8 this refinement is suggested to be a specific direction for future quantitative modelling.

5.3.4. Supplementary Model: Cost Perceptions and Income

The interaction of Cost and Financial Perceptions with household income was not significant ($b = -0.03$, $p = 0.866$, $N = 68$), suggesting that the impact of cost perceptions on adoption intention was not found to be significantly different across income levels in this sample. The null result needs to be viewed with special care because of the sample reduction due to income non-disclosure ('prefer not to say', 12 respondents). However, both lines of evidence lead to more fundamental conclusions: that the perception of cost is important for adoption intention, irrespective of how it is conceived; Cost and Financial Perceptions correlated significantly with Adoption Intention ($r = 0.43$, Table 3) and, independently of this moderation test, all five interview participants spontaneously and repeatedly mentioned cost as one of the two main factors when asked about their adoption decisions (Section 4.2.10). The convergence also reinforces the idea that affordability should be considered as a structural barrier by itself in the integrated framework, instead of being subsumed under Perceived Behavioural Control or Perceived Usefulness, which was discussed in Section 5.5.

5.4. Integration of Quantitative and Qualitative Strands

The two strands of this study—the quantitative and the qualitative—converge here to produce a single overall picture of intention to adopt EVs among the private consumers in this sample, extending and supplementing the quantitative picture, rather than simply restating it. The constructs that have the greatest quantitative evidence are the common ones across the two strands. EUPU and PEOU are the two significant direct predictors of EV intention regardless of which specification of regression is used, and the interview data contribute a concrete, mechanistic understanding of the meaning of these constructs in the EV context: the former as a trip-by-trip calculation which is weighted toward the limited number of trips for which an

EV is not suitable; the latter as an assessment almost entirely concerning the charging infrastructure and not the vehicle itself. This same level of support for HM1 is also found in detail in the interviews, where the environmental identity is at the core and motivating, then supporting but less important, then minor and discountable, with a similar pattern of the simple-slopes that was found in the moderation analysis.

The two strands branch off at an interesting point. The multivariate coefficient for Attitude is negative, and the other two (Subjective Norms and Perceived Behavioural Control) are non-significant, and this might be interpreted as evidence that the constructs are unimportant to the UK consumer's EV decision. The qualitative results clearly show that this is not the right variable in any of the three cases; in the first (attitude) it is consistently measured as positive and is found to be significantly mediated by environmental identity; in the second (subjective norms) it was always found to be significant, and its lack of significance in the regression is more plausibly attributed to shared variance with other variables and a near-binary distribution across the sample according to housing type, than to the absence of psychological significance; and in the third (perceived behavioural control) its non-significance is attributed to the shared variance with attitude and to the structure of the data in the study, which is near-binary across the sample based on housing type, rather than to an absence of psychological significance. The model also shows a quantitative difference; the quantitative model examines which constructs have unique statistical significance after controlling for competing explanations (attitude and perceived behavioural control), whereas the qualitative interviews provide insight into why constructs that do not have the same significance in the quantitative model are nonetheless substantively significant in how UK consumers actually reason about EV adoption.

5.5. Theoretical Implications

The research contributes to theory in three main ways in relation to the gaps outlined in Section 2.5.

- Architectural precision. The study has identified TAM constructs as analytically distinct from the TPB's attitudinal and control constructs, allowing for the demonstration that the TAM constructs have independent explanatory power for the EV adoption intention in a UK sample and overcome the imprecision of previous integration studies reported by Lieven (2015) and Zhang et al. (2020). In parallel, the results of the study indicate that the constructs of Perceived Behavioral Control and Perceived Ease of Use are not necessarily different constructs because of the low

discriminant validity between them, at least for the case of HM2, where the underlying constraint (home charging access) is structural and not solely psychological.

- This is the effect of environmental self-identity as a boundary condition to attitude. The finding of the HM1, along with the detailed qualitative confirmation, suggests attitude is not a universally direct predictor of EV adoption intention, but is rather a finder that is conditionally activated. This extends the original TPB model, where attitude usually is directly and unconditionally related to intentions, to the case of a pro-environmental durable-goods purchase.
- The case for the structural antecedents of charging and cost to be treated as separate variables from the psychological ones. Considering the qualitative theme of housing and parking, and the pattern of results across H3, HM2 and the supplementary cost model, we believe extending the integrated TPB–TAM framework with a structural layer, including housing type, charging infrastructure access and affordability, would be beneficial, as it can be partially operationalized within and partly beyond the psychological constructs the TPB and TAM specify. This aligns with, and extends, work presented by Anable et al. (2012) who found that the structural barriers to off-street parking are a first order obstacle to feasibility of EV adoption for the UK.

5.6. Practical and Policy Implications

The most obvious takeaway for policy makers from these two results is that positive public attitudes toward EVs on their own are not an indicator of adoption, as evidenced by the national survey consistently reporting that such attitudes exist (Deloitte, 2023) – and confirmed in this sample with a 7-point scale ($M = 5.00$) – and the public attitude toward the adoption of EVs is not clearly related to attitudes toward EV charging. The HM1 finding suggests that political campaigns and policy framing which use concepts related to environmental identity – and not blanket environmental messaging – may have stronger potential to move current positive attitudes towards purchase intention, especially for consumers who do not already consider environmental behaviour to be a central part of their identity.

Given the consistent findings that charging access was central to the qualitative theme, that there was a correlation with intention, and that there were group level differences in intention as related to EV experience status, it is reasonable to focus on home-charging enablement (e.g. permitting development of on-street and curb sides charging points, targeted grants to those who don't have off-street charging locations) rather than additional vehicle side incentives where vehicle usability was consistently rated high by participants in this sample. The

qualitative information indicates that the friction to be addressed is not simply charger density, but that interoperability – the one payment and access system for all public charging operators – was mentioned by participants on multiple occasions and was identified as a tangible and cost-effective policy move, since it does not need an additional physical deployment.

In terms of usefulness, the findings indicate that, for a vehicle manufacturer and dealer, the need to focus on the individual trip can be strengthened by product communication and marketing efforts such as running-cost and range-fit calculators tailored to the individual, at the point of sale. For charging network operators and local authorities, the non-significant HM3 result should not be interpreted as an argument that charging density is not important – rather, the qualitative results indicate that even further densification of the charging network might not be as important as reliability and standardization of the existing network, especially for the large proportion of UK consumers who do not have the possibility to charge at home and for whom public charging represents the main charging solution.

5.7. Limitations

There are some restrictions to consider regarding the conclusions that can be drawn from this study, in addition to the above findings.

1. Sample size and power. The achieved analytic sample ($N = 83$, further reduced to $N = 53$ in the primary hierarchical regression following listwise deletion) was below the minimum sample size recommended for testing individual predictors in a regression with five predictors by Green (1991); and several moderation tests were completed with an analytic sample that was reduced by non-disclosure of housing type and income. This reduces statistical power, in particular for the moderation hypotheses and non-significant results (H2, H3, HM2, HM3 and the additional income model) must not be interpreted as confirmed absence of effect, but as lack of evidence.
2. Non-probability, self-selected sample. The survey was sent as an open on-line link, and although stratification targets were set for geography, housing type and EV experience, the achieved sample was not a probability sample and there is no guarantee that it is representative for the UK private-consumer population; moreover, the high proportion of non-disclosures for income and housing type could also make for a systematic pattern of avoidance, rather than random missingness.
3. Absence of correction for multiple testing. In addition, there was no formal correction for multiple comparisons of the six analytical models estimated using overlapping data collected from the same sample, which could inflate Type I error; this was done to trade

off against the limited power available at this sample size anyway and the mediation and moderation results in particular should be viewed as exploratory rather than confirmatory.

4. Calculation of charging density in the region. As mentioned in Section 4.1.6 charging density was not measured at the individual respondent level, but instead imputed based on published aggregate statistics at a coarse binary classification which is likely to have reduced the HM3 test and may not have been reflective of participants lived charging environment. Qualitative sample in small size and not random. The qualitative phase was based on five participants, which is suitable for the exploratory and theory-elaborating objectives of the reflexive thematic analysis carried out, but themes found should not be interpreted as generalizations to the broader sample of UK EV considerers and the eight themes reported should be viewed as illustrative mechanisms rather than claims.
5. Cross-sectional design. The study provides only survey and interview data at a single point of time, so it describes associations between constructs and intention but it is unable to infer the temporal or causal ordering associated with the hypothesized model, or variations in attitudes, perceptions or intentions as the charging infrastructure and EV market evolves in the UK.

5.8. Directions for Future Research

1. The H2 and H3 results reported here, as well as the covariance-based structural equation modelling of the full integrated framework (which was not possible with the present sample size), would be testable in a larger, probability-based national sample, where the sample size is specifically tailored for the five-predictor model and the planned moderation tests.
2. Given the subsequent finding of a “structural” pattern of near-binary housing type, as a direct antecedent of Perceived Behavioural Control, rather than simply a moderator of the control–intention relationship, as done in prior studies.
3. Testing a three-way interaction between the variables Perceived Ease of Use, regional charging density and home charging access, based on the pattern found in the qualitative analysis in Section 5.3.3, as well as a directly measured (not imputed) charging-access individual-level variable.
4. As the charging infrastructure, price of EVs, and Zero Emission Vehicle mandate continue to change in the UK, it is important to see if the attitude–identity contingency

identified here (HM1) and the structural centrality of home charging (Theme 3, Theme 7) remains consistent as the market matures.

5. Modelling cost and charging access as antecedents both as direct and indirect, that is, respectively, through intention and TPB–TAM psychological constructs, instead of only as moderators of the latter.

5.9. Conclusion

The aim of this study was to investigate the extent to which an integrated TPB–TAM framework explains barriers to EV adoption for the UK private consumer population and the importance of each of these barriers in shaping EV adoption intention. The evidence suggests that overall, the integrated framework is a good fit, capturing 55–61 per cent of the variance in adoption intention across the model specifications, but that the constructs do not all work in the simple, independent, direct-effect mode as the original hypotheses suggested. A significant second pathway between Perceived Usefulness and Perceived Ease of Use emerged, with much of the qualitative data explaining that Perceived Usefulness is evaluated trip by trip, and Perceived Ease of Use involves the charging environment and not the vehicle itself. The moderating effect of environmental self-identity on the relationship between attitude and intention was found to be the strongest quantitative effect in the study and the most strongly supported by the interview data. Subjective norms were not the primary source of influence, but were a reassuring influence as opposed to a primary one, and whatever influence they did have, did not become statistically significant after the other predictors were controlled, while Perceived Behavioural Control was clearly the one most consistently significant barrier to adoption in the qualitative data, and was heavily influenced by housing type and availability of home charging infrastructure.

Together, the quantitative and qualitative strands reveal a new picture of the intention to adopt EVs in the UK in which being "willing to adopt" is commonplace and not often the limiting factor, and where access to affordable, convenient charging facilities, in particular at home, acts as the precondition that determines whether this willingness can be translated into intention and, eventually, adoption action. This has an obvious parallel in reality: increasing the number of EV owners will have a decreasing effect on changing their attitudes as increasing the number of charging points in their local area and making the public charging system easier to use will have a greater effect on this aspect. The main contribution of the study is the identification of this structural constraint at statistical association level, and the identification of its exact nature from an in-depth interface with those consumers it impacts, through a mixed methods design

that incorporates a nationally-oriented survey alongside in-depth interview work. The empirical evidence base developed in this study is intended to be directly usable by policy makers, infrastructure operators and vehicle manufacturers to bridge the persistent gap between positive EV attitudes and actual EV adoption in the United Kingdom.

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APPENDIX

Appendix A: Survey Questionnaire

All items (Sections B–E) were rated on a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree).

Section A: Demographic and Background Information

1. Age Group
2. Annual Household Income
3. Region of Residence
4. Housing Type
5. Current Vehicle Type
6. EV Consideration Status

Section B: Core TPB–TAM Constructs

Attitudes Toward EV Adoption

1. Owning an electric vehicle would be a good idea.
2. Owning an electric vehicle would be a wise choice.
3. I believe driving an electric vehicle is beneficial for the environment.
4. I think electric vehicles offer good value for money overall.

Subjective Norms

1. People who are important to me think I should switch to an electric vehicle.
2. My family and close friends would approve of me buying an electric vehicle.
3. Many people I know have already switched to an electric vehicle or are planning to.
4. I feel social pressure from my community to consider more environmentally friendly transport.
5. The opinions of others I respect would influence my decision to buy an EV.

Perceived Behavioural Control

1. I am confident in my ability to operate and maintain an electric vehicle.
2. I have access to a suitable location at home to charge an electric vehicle.
3. There are enough public charging stations near where I live and work.
4. It would be financially feasible for me to purchase an electric vehicle.
5. I feel I have enough knowledge about EVs to make an informed decision.
6. If I decided to switch to an EV, I would be able to do so without major difficulty.

Perceived Usefulness

1. Electric vehicles would reduce my day-to-day fuel and running costs significantly.
2. Using an electric vehicle would help me contribute meaningfully to reducing carbon emissions.
3. An electric vehicle would meet my daily driving needs effectively.
4. Electric vehicles perform as well as or better than petrol/diesel cars.
5. Switching to an EV would improve my overall transport experience.

Perceived Ease of Use

1. I think it would be easy to learn how to charge and operate an electric vehicle.
2. Finding and using public charging stations in the UK seems straightforward.
3. Managing home charging (installation, tariffs, scheduling) seems simple.
4. Understanding EV specifications (range, battery, charging speed) is not complicated.
5. Overall, I believe adopting an electric vehicle would require little extra effort compared to a conventional car.

Section C: Environmental Self-Identity

1. Being environmentally responsible is an important part of who I am.
2. I consider myself to be an environmentally conscious person.
3. I often make purchase decisions based on their environmental impact.
4. My concern for the environment influences my everyday choices.

Section D: Cost, Financial Perceptions, Infrastructure and Range Concerns

Cost and Financial Perceptions

1. The upfront purchase price of electric vehicles is too high compared to equivalent petrol/diesel cars.
2. Government financial incentives would significantly increase my likelihood of buying an EV.
3. I believe the long-term running costs of an EV are lower than those of a conventional car.
4. The cost of home charging installation is a significant financial barrier for me.
5. The removal of the UK Plug-in Car Grant has made EVs less affordable for me personally.

Infrastructure and Range Concerns

1. I worry that an EV's battery range would not be sufficient for my typical journeys.
2. I am concerned about the reliability of public charging infrastructure in the UK.
3. The lack of charging points near my home or workplace would prevent me from switching to an EV.
4. I am worried about being stranded without charge on a long journey.
5. The public charging network in the UK is inadequate for widespread EV ownership.

Section E: Adoption Intention (Dependent Variable)

1. I intend to purchase an electric vehicle as my next car.
2. I plan to seriously explore buying an electric vehicle within the next two years.
3. I would recommend electric vehicles to friends and family.
4. I would choose an electric vehicle over a petrol or diesel car.
5. I am willing to make sacrifices (e.g., adapt my driving habits) to switch to an EV.

Section F: Open-Ended Questions

Please answer the following questions in your own words. These help us understand the nuances behind your ratings.

1. What is one of the biggest factors preventing you from buying an electric vehicle right now? (Or, if you already own one, what was your biggest concern before purchasing?)
2. What information, support, or change would most increase your likelihood of switching to an EV?
3. Do you have any other comments about electric vehicles or the UK's transition to zero-emission transport?

Thank you for completing this survey. Your responses are greatly valued. Participants who wish to take part in a follow-up interview (approximately 30 minutes via video call) may indicate their interest below. Interview participants will be selected purposively.

Participation is entirely voluntary.

- I am willing to be contacted for a follow-up interview: ☐ Yes ☐ No
- Email address (optional) for interview contact: _____

Appendix B: Participant Information Sheet and Consent Form

Study Title: Barriers to Electric Vehicle Adoption Among Private Consumers in the United Kingdom: An Integrated TPB–TAM Framework

Researcher: Subu Khand

Institution: York St John University

Supervisor: Dr Ghulam Mujtaba

Purpose of the study: You are being invited to take part in a research study exploring the factors that influence private consumers' decisions about adopting electric vehicles in the UK.

What participation involves: If you agree to take part, you will be asked to complete a short online survey (approximately 10–15 minutes). A small number of survey respondents will also be invited to take part in a follow-up interview of approximately 30 minutes, conducted via video call and audio-recorded for transcription purposes.

Confidentiality and anonymity: All responses will be anonymized. No identifying information will be published in the thesis or any resulting outputs. Data will be stored securely and accessed only by the research team.

Voluntary participation: Participation is entirely voluntary. You may withdraw at any point without giving a reason and without any negative consequence.

Consent statement:

By proceeding with this survey / interview, I confirm that:

- I have read and understood the information provided above.
- I understand that my participation is voluntary and that I may withdraw at any time.
- I understand that my data will be anonymized and stored securely.
- I agree to take part in this study.
- (Interview only) I agree to the interview being audio-recorded and transcribed.

Participant signature (or electronic confirmation): _____

Date: _____

Appendix C: Ethical Approval Confirmation

This study received ethical approval from the [Institution name] Institutional Review Board / Ethics Committee prior to the commencement of data collection.

Date of approval: 29/05/2026

All data collection procedures, including the online survey and semi-structured interviews, were conducted in accordance with the UK General Data Protection Regulation (UK GDPR), the ethical guidelines of the British Psychological Society, and the ethical guidelines of the British Sociological Association, as outlined in Section 3.3.4.

