FACTORS INFLUENCING DEMAND IN THE EMERGING MARKET FOR LOW EMISSION VEHICLES

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ABSTRACT

Low Emission Vehicles (*LEVs*) are being developed and brought to market in order to address the issues surrounding greenhouse gas emissions connected to climate change, high urban pollution levels and concerns linked to energy security. How successful these vehicles are at mitigating these issues depends on their desirability to consumers. This research project takes a new approach to the investigation of consumer response to the introduction of LEVs by specifying a research framework which includes components that have received relatively little attention in this field of enquiry. Specifically, measurements relating to the concept of individual innovativeness from an innate and adoptive perspective have been taken to examine its influence over LEV perceptions. Additionally, situational factors associated with conditions unique to the LEV market have been examined to determine their affect. These situational factors include aspects such as environmental concern and the instrumental capability of LEVs in addition to more novel considerations such as symbolic, emotive and functional car meanings. Two models have been constructed using regression analysis to examine interactions between the research framework components. The data has been collected through the application of a self-completion household survey distributed over the cities of Dundee and Newcastle-upon-Tyne in the United Kingdom. Initial results indicate that individual innovativeness exhibits a muted role in explaining LEV perceptions, with situational factors appearing to hold more prominent influence.

INTRODUCTION

The United Kingdom and a number of other industrialised countries are facing significant challenges relating to commitments to reduce greenhouse gas emissions coupled with growing concerns over energy security. Low Emission Vehicles (*LEVs*) are being developed and brought to market in order to approach these issues. The effectiveness of these vehicles in addressing the aforementioned challenges will be dependent on their rate of market uptake. However, LEVs will be different compared to conventional Internal Combustion Engine (*ICE*) vehicles in a number of important ways which creates uncertainty about how consumers are likely to react to them. With the market being viewed as strategically important by UK *(1)* and European *(2)* Governments, understanding the likely diffusion of LEVs is a policy relevant and socially important field of enquiry.

This research aims to investigate how perceptions towards LEVs are being formed in the early market. Specifically, a research framework has been developed which includes components that have the potential to influence LEV perceptions yet have received relatively little attention in this field. The first of these components measures the concept of individual innovativeness from two distinct perspectives. To begin with, the socio-psychological personality trait of innate innovativeness is examined followed by an evaluation of adoptive innovativeness as observed by quantity of technology owned. Acknowledging the unique nature of this market, situational factors have been incorporated into the research framework which examined car attitudes, instrumental capabilities of LEVs alongside the ascription of symbolic, emotive and functional meanings to car use and ownership. This research framework has been applied by a self-completion household survey distributed over the cities of Dundee and Newcastle-upon-Tyne in the United Kingdom.

This paper will begin by briefly describing the previous literature that has been conducted in this field before outlining the research framework and the components it contains. Following this, a description of the data collection procedure will be offered before the results of the analysis are presented and discussed. To conclude, a summary will be provided which synthesizes the main findings of the research and considers the implications.

LITERATURE REVIEW

Academic activity in the field of LEV consumerism commenced in the United States in the early 1980s in response to the worldwide oil crises of the previous decade which generated a desire to increase energy security by diversifying a transport system highly dependent on petroleum *(3)*. Research often took the form of discrete choice modelling whereby respondents would be asked to state their preferences when presented with descriptions of cars employing a variety of powertrains *(4-8)*. Researchers utilising this approach often based their studies on the logit modelling methodology developed by McFadden *(9)*. Mannering and Train *(10)* provide a detailed review of this research direction describing the incremental improvements in these models which have expanded their variable sets whilst reducing their exposure to measurement error and bias. These models often took a functional approach to describing choice patterns, attempting to estimate demand alterations given marginal changes in vehicle characteristics such as purchase cost, size and acceleration. This research provided valuable insights relating to how functional LEV aspects affect preferences, allowing for technical endeavour to be focused on the attributes likely to generate the largest increases in demand.

Turrentine *(11)* provides a critique to this choice modelling approach arguing that, as consumers have little experience or understanding of these vehicles, their preferences towards them are likely to be unstable. More recent research has including additional dimensions which have influence over LEV preference. Kurani et al. *(12)* acknowledge the limitations of choice experiments and instead employ an exploratory approach which includes a household's entire stock of vehicles finding that perceived vehicle range requirements are significantly lower than previous research suggested. In a related piece of work, Kurani et al. *(13)* use a reflexive study to determine electric vehicle demand in multicar households and find that a large number of respondents choose to actively diversify the powertrain structure of their household fleets. Heffner et al. *(14)* investigate the symbolic meanings used by Hybrid Electric Vehicle (*HEVs*) owners in California finding a wide variation of symbolic attachments which are often linked to an owner's self identity. Following a similar direction,

Mau et al. *(15)* investigates the neighbour effect finding that rates of LEV adoption are likely to be influenced by the pre-existing level of market penetration in the case of evolutionary technologies, such as HEVs, but not for disruptive technologies, such as fuel cell vehicles. Taking a more social perspective, Axsen and Kurani *(16)* explore interpersonal influences relating to consumer perceptions of Plug-in Hybrid Electric Vehicles and find that consumers which have a social network that supports the societal values embodied by these vehicles tend to have more positive preferences towards them.

RESEARCH FRAMEWORK

To examine the importance of individual innovativeness and situational factors in the perceptions of LEVs, a bespoke research framework has been developed. This framework is illustrated in Figure 1 which displays the integrated components. These components have been placed into three categories [1] powertrain perceptions, [2] innovativeness and [3] situational factors and are described in the following sections.

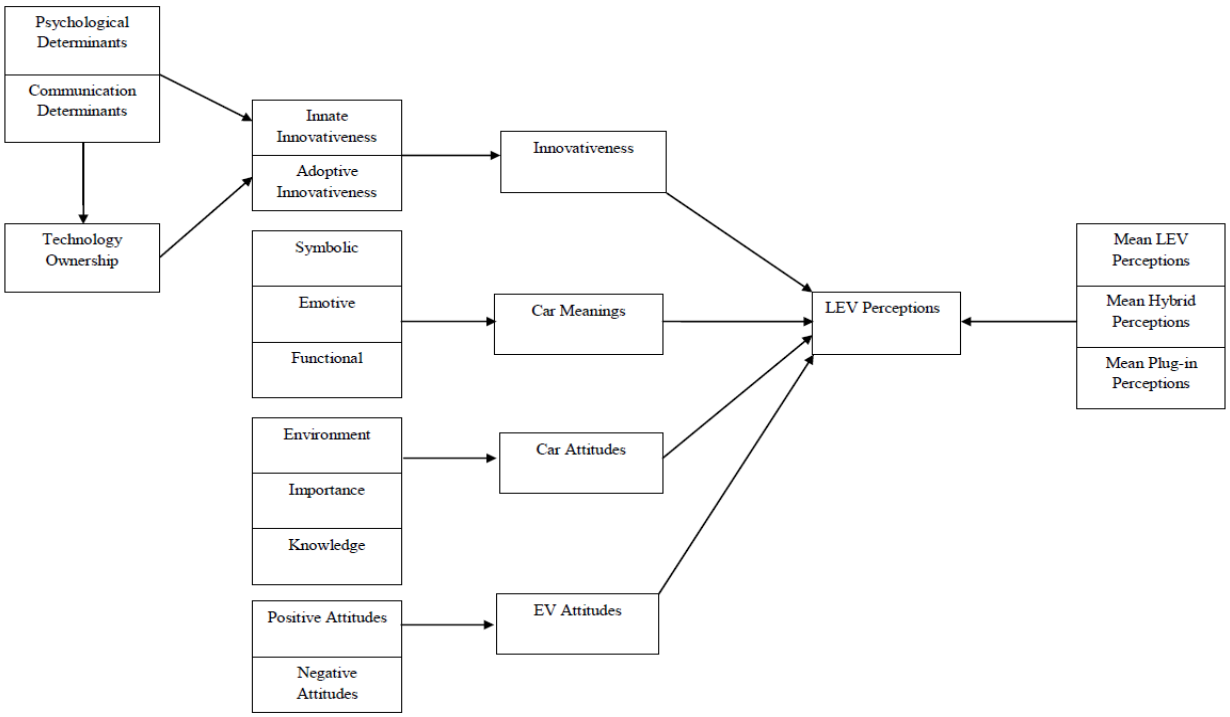


FIGURE 1 Illustration of the research framework with integrated components

Powertrain Perceptions

Measurement of LEV perceptions has been taken across six different options in a powertrain evaluation exercise conducted by the authors. Including the conventional options of [1] Petrol and [2] Diesel alongside the LEV options [3] Mild Hybrid, [4] Full Hybrid, [5] Plug-in Hybrid and [6] Pure Electric Vehicle (EV), respondents are asked to consider each powertrain individually and state their likelihood of selecting each option in their next car purchase. However, measuring LEV perceptions is a challenging task, prone to framing bias and influenced by pre-existing knowledge (*11*). Moreover, achieving an accurate measurement is vital to the robustness of this research given the central position of perceptions in the research framework.

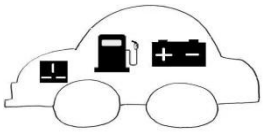
To ensure respondents are capable of making an informed decision when considering LEV powertrains, a two part information pack has been prepared and is partly illustrated in Figure 2. The first part of this pack provided an overview of the four LEV options, describing their main features and how they differ from conventional powertrains. This pack included graphical illustrations, similar

to those utilised by Axsen and Kurani (*17*), displaying the types of fuel source each powertrain can operate from. The second part follows a more traditional layout where the functional characteristics, such as carbon dioxide emissions, purchase price and operating costs, are provided for each of the six powertrain options to allow respondents to examine the differences in performance levels. To account for respondent unfamiliarity, a description was attached to each vehicle attribute. Following the evaluation exercise, respondents were asked to state the degree to which they considered the decision they made were correct with 70% responding in a confident manner.

The data collected from this stage of the survey has been used to calculate a number of different perception variables. Firstly, respondent average rating for the two none plug-in LEV options has been calculated with this variable labelled *Mean Hybrid Perception*. Secondly, respondent average rating for the two plug-in LEV options has been calculated with this variable labelled *Mean Plug-in Perception*.

Plug-in Hybrid

- Includes a **medium sized battery pack** as well as a conventional engine.
- The battery pack can be recharged from an **electricity outlet**
- The battery electricity can be used to drive the car **medium distances on electricity only**.
- When the battery pack is depleted the engine will **still operate** using conventional fuel.
- Purchase price is reduced by a **Government incentive grant**



	Engine Choice					
Attributes	**Petrol**	**Diesel**	**Mild Hybrid**	**Full Hybrid**	**Plug-in Hybrid**	**Pure Electric**
Total Range	300 miles	300 miles	300 miles	300 miles	300 miles	100 miles
Electric Range	0 miles	0 miles	0 miles	10 miles	20 miles	100 miles
Purchase Price	£12 000	£15 000	£18 000	£20 000	£23 000	£25 000
Operating Cost	£1000 pa	£850 pa	£650 pa	£500 pa	£300 pa	£150 pa
CO2 Emission	130 grams/km	110 grams/km	100 grams/km	90 grams/km	85 grams/km	75 grams/km
Brake Horse Power	110	100	90	90	90	80
Miles per Gallon	30	40	60	70	100	150

FIGURE 2 Illustration of the information pack displaying a description of the Plug-in Hybrid powertrain and the functional characteristics of all six options

Innovativeness

In the Diffusion of Innovation Theory (*18*), Rogers partitions individuals into five categories based on the length of time taken to adopt an innovation. This length of time can be considered to reflect an individual's particular level of innovativeness. The concept of innovativeness has been examined from different perspectives with Goldsmith et al. (*19*) utilising a three tiered approach encompassing innate, domain specific and adoptive innovativeness whilst Karande et al. (*20*) inspect the importance of time orientation. Midley and Dowling (*21*) discuss the conceptual difficulties in defining

innovativeness and propose a model combining psychological and social aspects which influence innate innovativeness. However, innate innovativeness does not directly transfer into adoptive behaviour, but is affected by situational factors unique to the innovation which may enhance or hinder adoption. More recently, Roehrich (*22)* provides a critical review of the definitions of innovativeness and associated measurement strategies, finding that previous applied research in this field lacks predictive validity and calls for a more robust theoretical foundation to be established.

Acknowledging this request, this research integrates Midley and Dowling's conceptual model with Roger's generalisations of innovators to develop three distinct measurements of innovativeness. Firstly, two socio-psychological scales have been constructed to measure the personality trait of innate innovativeness. The first of these scales examines the psychological determinants of innovativeness including such aspects as ambition and rationality whilst the second reflects communication determinants such as change agent contact and opinion leadership. Secondly, adoptive innovativeness has been measured by asking respondents to state their ownership of a pre-specified list of household technology including items such as tablet computers, media centres and smart phones. It is assumed that those individuals that own greater quantities of consumer technology exhibit higher degrees of adoptive innovativeness.

Situational Factors

It is unlikely that an individual will behave in a universally innovative manner across all different circumstances and environments. Midley and Dowling (*21*) account for this by the recognition of situational factors, unique to the particular innovation, which may influence levels of adoption. These factors have been incorporated in this study by the measurement of a number of socio-psychological constructs.

Past research in this field has taken a distinctly functional approach to assessing LEV perceptions, determining the influence of performance attributes such as range and operating costs. Steg (*23*) critiques the limitations of this perspective by examining the importance of symbolic and emotive meanings and their effects on transport behaviour. This approach has seen partial application in the LEV demand field. Skippon and Garwood *(24)* investigated the interaction between symbolic meaning and functional performance of EVs whilst Franke et al. *(25)* examined the influence of emotive response to experiencing range limitation in EVs. In this research, an attitudinal scale has been developed and applied based on the work conducted by Dittmar *(26)* and Richins *(27)* to measure the ascription of symbolic, emotive and functional meanings to car use and ownership and observe their influence over LEV perceptions.

LEVs incorporate unique functional capabilities leading to improvements in instrumental performance in certain areas and limitations in others. To examine the unique influence of EV functional attributes in particular, an attitudinal scale has been developed and applied. This scale incorporates aspects such as limited range and purchase premiums alongside more positive considerations linked with decentralised fuelling and lower operating costs. Attitudes towards the environment have been found in previous research to positively influence LEV perceptions (*28*). This has been incorporated in the research framework by measuring concern for the environmental consequences of car use and willingness to act. Moreover, the research framework incorporates two additional components which measure the perceived importance attributed to car ownership and level of car knowledge.

RESEARCH METHODOLOGY

To apply the research framework, a self-completion household survey has been distributed over two sites in the United Kingdom. The study sites are the cities of Newcastle-upon-Tyne and Dundee with each receiving a distribution of 2000 surveys. To ensure the survey has been evenly distributed over the city populace, a stratified random sampling approach has been employed using the Index of Multiple Deprivation as a benchmark (*29*). This index provides a composite measure for all areas within the UK including aspects related to household income, employment levels and crime at a high level of resolution. Specifically, 3 zones have been selected in each city to represent an area of low, medium and high level of deprivation.

In total, 552 surveys were returned with 46 surveys removed due to lack of completion equating to a net response rate of 12.7%. The demographic profile of the sample and how it compares to the UK populace is detailed in Table 1. A number of noticeable differences are apparent, with the sample over representing older members of the populace, which is also observed by a higher proportion of retired individuals in the sample, and also males in general. To examine if this disparity in sample demographics may influence the results generated in the models of LEV perception, respondent age, gender, level of education and gross household income have been included as a block of control variables in the regression analysis. Two significant results were identified in the Mean LEV perceptions model with age holding a negative influence and gender holding a positive influence (with females coded as 1 and males as 0) indicating that demographic aspects are also influencing perceptions in this emerging market.

TABLE 1 Comparison between key statistics of the sample and population [a] (*30*) [b] (*31*) [c] (*32*)

Variable	Category	Population	Sample
Car Ownership [a]	No car	25%	11%
	One car	42%	54%
	Two or more cars	33%	35%
Annual car mileage [a]	Mean	8430	8260
Age (years) [b]	18-30	22%	6%
	31-50	35%	27%
	51-65	23%	37%
	65+	20%	30%
Gender [b]	Male	49.17	59.1
	Female	50.83	40.9
Employment Status [c]	Full time employment	42%	46%
	Part time employment	16%	9%
	Unemployed	5%	1%
	Economically inactive	18%	4%
	Retired	19%	40%
Gross Household Income (GBP) [c]	< 10, 000	9%	7%
	10 - 30, 000	44%	40%
	30 - 50,000	24%	28%
	50 - 70.000	12%	14%
	70 - 90,000	5%	7%
	> 90, 000	6%	6%

RESULTS AND DISCUSSION

The results of this research will be presented and discussed in three stages. To begin, the measurement of the socio-psychological constructs related to innovativeness and situational factors will be described. Following this, two regression models will be specified. The first will evaluate the effectiveness of the innate innovativeness measurements by examining their ability to explain ownership of household technology. The second will examine the influence of innovativeness alongside the situational factors in explaining LEV perceptions.

In total, thirteen socio-psychological constructs have been extracted from six unique attitudinal scales to examine their influence over LEV perceptions. Principal Components Analysis (PCA) (*33*) was used in the identification of these constructs coupled with Varimax Rotation (*34*). The Kaiser Criterion (*35*) was used to determine the appropriate number of components to extract from each scale with factor scores calculated using the Regression method (*36*). To evaluate the reliability of construct measurement, a Cronbach Alpha (α) *(37)* has been calculated for each component. Additionally, the Kaiser-Meyer-Olkin (*KMO*) measure of sampling adequacy and Bartlett's test of sphericity have been calculated for each scale which provided satisfactory results in all cases (*38*).

TABLE 2 PCA output with item loadings and component Cronbach alphas related to determinants of innate innovativeness

1. *Communication: Information Seeking and Provision* α - .865	
Friends and colleagues regularly come to me about advice concerning new consumer technology	.890
I often know about the next 'must have' piece of consumer technology before it is released into the market	.885
I regularly seek information about the latest consumer technology	.881
I keep up-to-date with consumer technology by reading newspapers/magazines, websites or relevant TV shows	.751
I have frequent contact with people working with new consumer technology	.526
2. *Communication: Social Activity* α -.548	
My friends and family would say I was a cosmopolitan person	.738
I often socialise with people from a large variety of different backgrounds	.723
I regularly participate in activities such as sports, clubs and/or associations that have a formal structure	.674
I have a small group of friends who all know each other well and share similar interests	.355
1. *Psychological: Decision Making and Ambition* α - .737	
I have confidence in myself in making the right decision in complicated situations	.808
I prefer to let other people make decisions when I am not completely sure about the situation	-.734
I quickly incorporate new ideas into how I live my life	.512
I'm a very ambitious person setting high standards and expectations for myself	.497
My friends and family would consider me to be an innovative person	.494
2. *Psychological: Science and Education* α - .589	
Science has no impact on how I live my life	-.745
I really enjoyed my science classes at school	.687
I rarely use the things I learned in formal education in my daily life	-.618
I enjoy learning about new things	.554
3. *Psychological: Aspiration* α - .450	
I'm never satisfied with my current position in life	.701
I'm always looking for ways to alter my life to make it better	.670
Making sure I always make the correct decision is something that is important to me	.607
4. *Psychological: Compulsive* α - .381	
Compulsive behaviour usually governs my purchasing decisions	.756
I'm usually one of the first people to acquire the latest consumer technology	.595

Examining the measurements of innate innovativeness to begin, six components have been identified from the analysis and are displayed in Table 2. Two of these components are associated with communication determinants whilst the remaining four are connected to psychological determinants. Inspecting the component structures, it is apparent that the communication determinants have partitioned into those related to knowledge concerning innovations specifically and social behaviour in general. Relating to the psychological determinants, the output is somewhat less clear with Components 1 and 3 appearing to be similar, both being constructed of items linked with ambition and decision making ability. The second component is positively orientated towards science and education attitudes whilst the last component links the early adoption of new consumer technology to compulsive behaviour. This connection was unexpected. Compulsive behaviour was included in the scale to measure rationality, which is stated as a determinant of innovativeness, from a

negative orientation. However, the assumption that compulsive behaviour is a form of irrationality is perhaps questionable, though past research has found compulsive behaviour to be related to a loss of self control and diminished decision making ability (*39-40*).

TABLE 3 PCA output with item loadings and component Cronbach alphas related to situational factors

1. *Car Meanings: Symbolism and Emotion* ("I think a car most of the time can…") α - .907	
Improve my appearance or the way I look	0.881
Make others think well of me	0.877
Provide me with social status	0.857
Improve my mood	0.764
Provide emotional security	0.749
Be beautiful or attractive in appearance	0.71
Allow me to express myself	0.672
2. *Car Meanings: Function* ("I think a car most of the time can…") α - .659	
Allow me to be efficient in my daily life and work	0.703
Be a sensible financial decision	0.676
Provide enjoyment	0.631
Have a lot of practical usefulness	0.616
Be a hassle	-0.574
1. *Car Attitude: Importance* α - .805	
If my car was stolen, I'd feel as if I had lost a part of myself	0.838
I consider my car to be part of the family	0.82
The car I drive is irreplaceable	0.786
My car is the most important thing I own	0.664
I often treat my car as if it were a person	0.647
Without my car, my life would become very difficult	0.545
2. *Car Attitude: Knowledge* α - .772	
I know how my car works on a mechanical level	0.912
I'm capable of fixing any rudimentary problems with my car	0.832
I know a lot about the new types of cars (such as hybrid and electric cars) being released into the car market	0.707
3. *Car Attitudes: Environment* α - .785	
I am concerned about the environmental impact of driving my car	0.875
I am willing to spend more on a car that has lower pollution levels	0.819
I think it is my responsibility to reduce the environmental impact of driving my car	0.81
I am willing to spend more on a car that has better fuel economy	0.523
1. *Negative EV Attitudes* α - .701	
Electric cars are less reliable than conventional cars	0.794
I would feel relatively less safe in an electric car	0.778
I think electric cars would be complicated to use	0.768
Electric cars don't offer enough performance	0.518
2. *Positive EV Attitudes* α - .495	
I think I can fulfil all my transport needs with an electric car that has a range of 100 miles before recharging	0.715
Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	0.657
I would value the ability to refuel my car from home	0.588
I think it would be easy for me to find places to plug in an electric car	0.497

In reference to the situational factors, seven components have been identified and are presented in Table 3. Two components have been extracted from the scale measuring symbolic, emotive and functional car meanings. The first of these components contains symbolic and emotive items, which appear to be interwoven throughout the component structure, whilst the second is predominately focused on functional aspects. Car attitudes have been partitioned into three components, the first containing items associated with the essential nature of car ownership and personification whereas the second connects with car knowledge. The third car attitude component reflects concern for the environmental consequences of car use and willingness to act. Interestingly, this component includes an item linked with willingness to pay more for a car with better fuel efficiency, indicating that a cognitive link between fuel efficiency and levels of pollution has been attained. The final two components are linked to the functional capability of EVs in particular with the first containing items associated with negative opinions whilst the second component is positively orientated.

To evaluate the effectiveness of the innovativeness measurements, a regression analysis has been conducted. The components associated with communication and psychological determinants of innate innovativeness are utilised in as independent variables in an effort to explain quantity of household technology owned, a measurement of adoptive innovativeness. The results of this analysis are displayed in Table 4 where four out of the six components exhibit significant explanatory power. Both of the components associated with communication determinants appear to positively influence the ownership of household technology. In addition, psychological determinants hold influence with the components linked with decision making and ambition alongside compulsive behaviour positively affecting household technology ownership. This result suggests that innovativeness, whilst not directly observable, can be indirectly measured by examining its constituting determinants. Furthermore, these determinants can be used to explain the adoption of innovations. Whilst four of the components appear to significantly explain adoptive behaviour, a number of the Cronbach alphas fall below acceptable levels of tolerance for internal consistency. The components *Communication: Information Seeking and Provision* and *Psychological: Decision Making and Ambition* display alphas above the acceptable level of 0.6 and will be utilised to examine the influence of innovativeness over LEV perceptions.

TABLE 4 OLS regression analysis using quantity of household technology owned as dependent variable and innate innovativeness constructs as independent variables - R^2 0.207 - * p < 0.05 ** p < 0.01

Independent Variable	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	4.267	0.104		41.088	0
Communication: Information Seeking and Provision	0.614	0.127	**.236****	4.826	0
Communication: Social Activity	0.26	0.11	**.100***	2.362	0.019
Psychological: Decision Making and Ambition	0.265	0.11	**.102***	2.413	0.016
Psychological: Science and Education	0.156	0.112	0.06	1.392	0.164
Psychological: Aspiration	0.06	0.108	0.023	0.561	0.575
Psychological: Compulsive	0.604	0.117	**.232****	5.169	0

To determine the influence of innovativeness alongside situational factors over LEV perceptions, two regression analyses have been conducted with the results presented in Table 5. Utilising the two measurements attained in the LEV evaluation exercise as dependent variables, ten variables measuring innovativeness and situational factors are included as independent variables to identify which hold significant explanatory power. Inspecting the results, it is apparent that innovativeness, as it has been defined and measured in this research, does not substantially influence LEV perceptions. One significant result is observed, with the communication determinant of innate innovativeness linked to knowledge and information concerning innovations positively influencing perceptions of hybrid LEV powertrains. This finding suggests that ensuring information relating to

LEVs is positively publicized and easy to access may enhance perceptions and, potentially, adoption rates.

This predominately negative result implies that innovativeness does not currently hold a primary role in the evaluation of LEVs. LEVs may not currently be considered a form of innovative technology, leading to those individuals with high levels of innovativeness being no more attracted to LEVs than other consumers. However, this lack of result may be motivated by how innovativeness has been measured in this research, which has focused on the abstract nature of innate innovativeness positioned as a unique personality trait alongside overall level of technology ownership. Perhaps a more specific approach, concentrating on the innovative aspects of LEVs in particular, would have produced a different result. Conversely, the situational factors appear to hold significantly more explanatory power over LEV perceptions. Examining the components related to the car meanings scale, it appears as though a desire for a functional car which is financially sensible, useful and easy to use negatively affects hybrid LEV perceptions. In a similar manner, those individuals that place symbolic and emotive meanings on car use and ownership appear to have lower perceptions of plug-in LEVs in particular. These results indicate that LEVs may be attached to adverse meanings which are undesirable to those individuals that place importance on symbolic, functional and emotive car aspects.

The construct *Car Attitude: Knowledge* was included to gauge car involvement, with those individuals that have understanding of and capability with the fundamental workings of cars assumed to hold a greater interest in them. This construct holds a negative influence over perceptions of hybrid LEVs suggesting that individuals that are knowledgeable about cars may not hold positive perceptions of LEVs. This result is of importance as those individuals who are knowledgeable about certain products often act as opinion leaders, providing information to their social networks (*41*). This relationship is supported by a positive correlation between the components *Car Attitude: Knowledge* and *Communication: Information Seeking and Provision* (0.378**). If opinion leaders do not support LEVs, this has the potential to negatively affect their rates of adoption.

Supporting the findings of previous research, the component *Car Attitudes: Environment* exhibits a positive influence over LEV perceptions. This result signifies that individuals who are concerned about the environmental consequences of car use and willing to act are more likely to consider an LEV powertrain in their next car purchase. The final two components which hold influence in the regression analysis connect to the functional capacity of EVs specifically. In this instance, the observed results follow expectations with positive attitudes appearing to assist plug-in LEV perceptions whilst negative attitudes act as a hindrance. Thus, emphasising the positive instrumental capabilities of LEVs and ensuring this information is present and easy to access will likely enhance adoption rates.

TABLE 5 OLS regression analysis using LEV perceptions as dependent variables and innovativeness and situational factors as independent variables * p < 0.05 ** p < 0.01

Independent Variable	Mean Hybrid Perceptions		Mean Plug-in Perceptions	
	Beta	Sig.	Beta	Sig.
(Constant)	2.989	0.000	1.950	0.000
Communication: Information Seeking and Provision	**0.158****	0.009	0.021	0.716
Psychological: Decision Making and Ambition	0.034	0.508	0.061	0.220
Total Household Technology Owned	0.051	0.348	0.091	0.084
Meaning: Symbolism and Emotion	-0.013	0.817	**-0.114***	0.033
Meaning: Function	**-0.122***	0.022	-0.043	0.402
Car Attitude: Importance	0.009	0.876	0.055	0.326
Car Attitude: Knowledge	**-0.118***	0.041	-0.067	0.230
Car Attitude: Environment	**0.184****	0.000	**0.235****	0.000
Negative EV Attitudes	-0.086	0.113	**-0.117***	0.026
Positive EV Attitudes	0.017	0.745	**0.163****	0.001
R^2	0.106		0.154	

SUMMARY

This research has examined the influence of a number of socio-psychological constructs on perceptions of Low Emission Vehicles. Specifically, the concept of innovativeness has been measured from an innate and adoptive perspective to observe if this is affecting the evaluation of these vehicles. Additionally, situational factors linked with considerations specific to this market are assessed encompassing [1] symbolic, emotive and functional car meanings, [2] car attitudes linked with importance, knowledge and environmental concerns and [3] aspects linked to the functional performance of EVs.

Perceptions of LEVs have been measured through the application of a powertrain evaluation exercise whilst the socio-psychological constructs have been determined through a Principal Components Analysis of attitudinal scales. Results suggest that innovativeness does not currently hold substantial influence over evaluations and perceptions of LEVs. From the regression models specified, the only measurement of innovativeness to display significant explanatory power over LEV perceptions is associated with knowledge about innovations. Conversely, the situational factors measured hold a comparatively greater influence. In this instance, results indicate that concern for the environmental implications of vehicle use is a significant factor in perceptions of LEVs which supports the findings of previous research. In addition, the level of functional meaning placed on car ownership appears to negatively affect hybrid LEV perceptions, with the same being true of symbolic and emotive meanings on plug-in LEV perceptions. The importance of instrumental vehicle considerations is reinforced by the finding that attitudes towards the functional capabilities of EVs in particular significantly affect the perceptions of plug-in vehicles. Additionally, the level of knowledge relating to the fundamental operation of cars holds a negative influence over hybrid LEV perceptions, suggesting that individuals with higher degrees of car knowledge may hold negative opinions of LEVs.

These results suggest that, in the early market for LEVs, situational factors are dominant in the evaluation of these vehicles. Innate innovativeness, as it has been defined and measured in this research, does appear to exert significant influence over adoption levels of household technology however, it does not appear to substantially affect perceptions of LEVs. This finding may originate from different sources. LEVs may not currently be considered a form of innovative technology, situational factors and other dimensions such as systems compatibility may dominate perceptions or, more simply, innovativeness may not play a primary role in the diffusion of these vehicles. However, these possible interpretations should be considered with caution. A significant limitation of this research is the comparison of innovativeness with LEV perceptions due to the diffusion of these vehicles remaining limited. If instead, innovativeness had been compared to actual adoptive behaviour of LEVs, this would have provided a more direct conceptual link allowing for a greater degree of certainty in the validity of the results generated. This specific area could benefit from additional research to determine if a barrier between innovativeness and LEV perceptions does exist through the examination of domain specific aspects as opposed to the more abstract approach to innovativeness used in this research.

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