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Public Opinion and Understanding of the Impact of Electric Vehicles: A UK Experience

Joshua Kennedy
University of the West of Scotland, Paisley, UK

Kieran James
University of the West of Scotland, Paisley, UK

Bonnie Hampson
University of Southern Queensland, Toowoomba, Australia

ABSTRACT

The UK Government places pressure on the automotive industry to reduce carbon emissions by prioritising the manufacture of alternative fuel vehicles. Hence, electric vehicles (EVs) are a priority for the automotive industry given they emit minimal carbon emissions compared to petrol and diesel vehicles. Despite the continued improvement in the manufacture of EVs, issues regarding the viability and affordability of the vehicles influence the market for EVs. This paper explores opinions regarding (i) the viability and environmental impact of EVs as a replacement for petrol/diesel vehicles; (ii) the affordability of EVs; and (iii) knowledge and familiarity of the use of EVs. 130 respondents to a questionnaire, along with interviews with participants within the automotive industry inlcuding an owner of an EV, generally supported literature on the study of EVs. Findings of this research identified that views relating to the viability of EVs focussed on range anxiety, charging speeds and battery life. Views relating to the affordability of EVs are influenced by the initial purchase price of the vehicle, along with costs associated with the battery and charging point. Finally, it is clear that consumers with greater knowledge about EV technologies are more likely to embrace EVs.

Keywords: Electric Vehicles, Carbon emissions, Affordability of EVs, environmental impact.

INTRODUCTION

With an international focus on reducing carbon emissions, the automotive industry responds with a shift in focus from vehicles using fossil fuels to those using alternative fuels. With the aim to prevent human induced interference with the climate system, the 1994 United Nations Framework Convention on Climate Change looked to industrialzed countries, including the United Kingdon, to cut emissions by the year 2000 to 1990 levels. The United Kingdom's Climate Change Act of 2008 (the Act), in mandating national emissions reductions, recommended greenhouse gas emissions be reduced by at least 80% by 2050 and by 34% by 2022. Despite targets being considered problematic (Anderson, Bows & Mander, 2008), the 2019 amendment of the Act set legally-binding carbon budgets revising the targets to achieve

net zero emissions by 2050[1] (Gov.UK, 2019). Setting targets to be acheived five years earlier than the UK, Scotland introduced legislation[2] setting net zero targets by 2045 (Gov.SCOT, 2021).

Recognising that petrol and diesal vehicles significantly contribute to carbon emissions, the UK Government prioritises the phase out of the sale of all new petrol and diesel cars and vans by 2030. New hybrids have an extension to 2035 provided they are capable of zero emissions over a significant distance (HM Government, 2020). Such a mandate places pressure on the automotive industry to reduce carbon emissions by prioritising the manufacture of alternative fuel vehicles. Hence, electric vehicles (EVs) are a priority for the automotive industry given they emit minimal carbon emissions compared to petrol and diesel vehicles. Despite the continued improvement in the manufacture of EVs, issues regarding the viability and affordability of the vehicles influence the market for EVs.

Recognising industry testing of alternative fuels such as natural gas (methane or propane), bio-methane, biodiesel and bioethanol technologies, this paper focuses on battery powered EVS and Plug in Hybrid EVs. This study explores public views regarding (i) the viability and environmental impact of EVs as a replacement for petrol/diesel vehicles; (ii) the affordability of EVs; and (iii) knowledge and familiarity of the use of EVs.

This paper is organised as follows. The next section of this paper provides a briefing of the evolution of EVs dated from the 19th century to the present day. The terminology commonly used in EV technology as well as the variety of EVs available to the public and organisations is also discussed. Secondly, literature related to opinions concerning the viability and environmental impact of the EVs; the affordability of EVs; and the extent of knowledge and familiarity of the use of EVs is presented. Thirdly, the research methodology is discussed. This is followed by an outline of the empirical findings and discussion. Lastly conclusions are drawn. Limitations of this study are highlighted, and finally suggestions for further research.

EVOLUTION OF EVS

The evolution of EVs dates back to the 19th century. Its development was made possible through the advancement of technology in the 1800s. There are differing opinions on where, and when the first EVs originated. Guarnieri (2012) awards the birth of EV technology to the early 1800s. "In 1827 Slovak-Hungarian priest Ányos Jedlik (1800-1895) built the first crude but viable electric motor, provided with stator, rotor and commutator, and the year after used it to power a tiny car" (pg 1).

The technology for EVs used today originated from the development of electromechanical dc generators that creates direct current using a commutator. The 19th century saw the: breakthrough of practical technologies such as dc power transmission, electric cars, and electric railways, which all first emerged in urban contexts" (Guarnieri, 2020:72). The first EV is said to have been manufactured on 1887 which used a storage battery and an electric motor that powered the rear wheels and allowed the vehicle to travel up to 10 miles per hour. While this

[1] See The Climate Change Act 2008 (2050 Target Amendment) Order 2019, available at https://www.legislation.gov.uk/uksi/2019/1056/contents/made

[2] See Climate Change (Scotland) Act 2009

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invention was not a success as the time, it is considered a significant milestone for the creation of EVs (Strohl, 2020). Ferdinand Porsche, founder of the sports car company of the same name, invented the P1 in 1898 which was capable of reaching up to 22 miles per hour and a maximum distance of approximately 49 miles (Porsche, 2019).

The turn of 20th century, saw a boom in the use of EVs. In New York City, the majority of taxis in the city were electric, with the city's fleet growing to over 60 cars. It is also believed that a third of the cars in the US were electric, with EV sales higher than internal combustion engine (ICE) vehicles in 1899 and 1900. However, EVs were expensive to run and the technology at the time did not allow for suitable transportation, as the batteries used to power the EVs were either non-rechargeable or were not able to travel long distances without recharging. As noted, Ziegler & Abdelkafi (2022: pg 1), in 1914 The New York Times reported:

> *"The fact is that Mr. Edison and I have been working for some years on an electric automobile which would be cheap and practicable. Cars have been built for experimental purposes, and we are satisfied now that the way is clear to success. The problem so far has been to build a storage battery of light weight which would operate for long distances without recharging. Mr. Edison has been experimenting with such a battery for some time." -Henry Ford, The New York Times, 1914, p.10*

Due to issues relating to battery storage enabling the travel of longer distances, interest in EVs stalled and the introduction of ICE vehicles eventuated in early 20th century. ICE vehicles were much cheaper to run as they were powered by fossil fuels. While Ford was actively experimenting with EVs, he produced the Model T as a less expensive, mass-produced vehicle that was more affordable and available to the general public. The Model T was reasonably priced at roughly $850. Affordability contributed to the success of ICE vehicles in the early 20th century. In 1912, the average ICE vehicle cost $650, whilst the average cost of an EV was $1,750. The attractiveness of gasoline powered vehicles coincided with a huge discovery of oil in the US state of Texas ((Texas Almanac, 2021). This led to a decrease in the price of gasoline, which allowed for greater affordability of ICE vehicles for consumers. Consequently, the popularity and sales of EVs decreased dramatically and their manufacture stalled.

The attractiveness of ICE vehicles lay in their ability to travel long distances, something that EVs were lacking. Along with improved infrastructure on roads and highways after the second World War, ICE vehicles enalbled motorists to travel all over the country. By 1923, the price of a Ford Model T had decreased to around $300, whilst some EVs cost almost ten times as much (Wilson, 2018). The high price of an EV was attributable to cost of its battery. Low prices of gasoline, increasing variety of models, and overall cheap car prices saw ICE vehicles as the dominant force in the automobile industry. Hence, gasoline powered vehicles remained popular till the late 1960s, increasing gasoline prices in the late 1960s increased substantially due to a worldwide shortage. Interest in EVs was reignited.

As interest in EVs grew, research highlighted the environmental benefits of EVs. This attracted governments attention resulting the US Congress, in 1976, legislating The Electric and Hybrid Vehicle Research, Development, and Demonstration Act. The enactment led to the Department of Energy launching a major battery development program in 1978 for near-term EVs (Webster & Yao, 1980). Despite this legislation, issues continued to plague the EVs ability to travel long

distances or reach relatively high speeds. This led to a shift in focus to hybrid EVs, which used a combination of gasoline and an electric battery to power the vehicle. While this technology performed better than traditionally battery powered EVs, they were still no match for gasoline powered ICE vehicles.

The 1990s witnessed an all-time interest in and research of EVs. Automakers resumed the manufacture of EVs using technology from ICE vehicles to modify their existing range of models into EVs (Department of Energy, 2014). This resulted in the first mass produced EV: The Toyota Prius. Despite other worldwide automakers introducing their own range of EVs This model laid the foundations for other major worldwide automakers to introduce their own EV models (Nissan Altra, Chevrolet S-10 Electric, and Ford Ranger EV), none were as successful as the Toyota Prius. Hence, many were eventually cut from production.

The heavy reliance on ICE vehicles in the 20th century, contributed to the acceleration of the climate crisis being witnessed today. As the effects of climate change became more apparent, the automotive industry was under more pressure than ever to provide alternatives to ICE vehicles. By the mid 2000s, more automakers were dipping into the EV market and producing their own models. In 2006, a Silicon Valley start-up called Tesla Motors designed the Tesla Roadster, a luxury electric sports car with the capability to travel over 200 miles on a single charge. This was a significant advancement as previous EVs were unable to travel such distances.

As the success of Tesla became common knowledge, automakers endeavoured to follow suit. Many shifted focuses from Hybrid EVs to EVs fully powered by battery. In 2010, Nissan launched the Nissan Leaf. While the Leaf was big breakthrough enabling a travel distance of 125 miles, it could not match the range of distance of over 200 miles the Tesla Model T offered.

While the variety of EVs grew, its high purchase price made it difficult for the average consumer to afford an EV over an ICE vehicle. To combat this, governments introduced incentives and schemes in the hope that it would increase sales of EVs. In 2011, The UK Government announced the Plug-In Car Grant (PICG) which offered grants which allowed customers to claim up to £4,500 towards a new EV. When first introduced, the grant was split into three categories. This grant has been modified several times since 2011, resulting the new grant rate of £3,500 for category 1 vehicles which "reflects the recent reductions in the price of electric vehicles" (Gov.UK, 2018). This modification meant that Hybrid EVs were no longer eligible for the grant. However, "these vehicles will continue to receive support through lower car tax rates, grants for charging infrastructure and local incentives (such as free parking)" (Gov.uk, 2018). Claiming success of PICG the UK Government reported the program has provided a discount to the price of over 160,000 new ultra-low emission vehicles" (Gov.UK, 2018).

To achieve mass-scale adoption of EVs, improved infrastructure for battery charging purposes is essential. Schultz and Rode's study on the impact of public charging infrastructure in Norway reported "we find that the first establishment of charging infrastructure subsequently increases BEV diffusion by more than 200% after five years" (2022, p. 7). This study noted that given that Norway ranks among the countries with the highest home charging availability worldwide. 74.8% of the new car sales in Norway in 2020 were plug-in electric vehicles (Richter, 2021). The Norway study demonstrated the importance of improved charging infrastructure.

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Society and governments around the world increase pressure on the car industry to lower carbon emissions. In response to this pressure, a variety of EVs are now available. Petrol and diesel vehicles use ICE's that require fossil fuels. Petroleum, for example, accounts for 90% of the world's transportation requirement contributing to polluting emissions, especially of carbon dioxide (WWF, 2021).

Battery Electric Vehicles (BEV) only use a chargeable battery for power. They are charged via plug in charging points that are available publicly. The major upside to BEVs is undoubtedly their zero CO2 emissions. They only emit C02 emissions when producing electricity to charge the vehicle.

Hybrid EVs (HEV's) are vehicles that use a combination of ICE and an electric battery. The battery is charged in two ways. Firstly, the battery's charge comes from excess energy from the ICE and kinetic energy that charges the battery when the vehicle brakes. Although HEV's, such as Toyoata Prius, still use ICE's, HEV's produce are more environmentally friendly vehicle that achieves lower emissions, compared to vehicles that only use ICEs.

Plug in Hybrid Electric Vehicles (PHEVs) are similar to HEVs as they use a combination of an ICE and a plug-in electric battery. PHEVs generally have longer range capabilities than standard Battery EVs (BEVs). PHEVs are considered "range extended" models of BEVs. They contain smaller ICE that generate electricity when the battery begins to run out. This allows flexibility for the use of the electric battery during short usage, and the use of the petrol engine for longer trips.

LITERATURE REVIEW

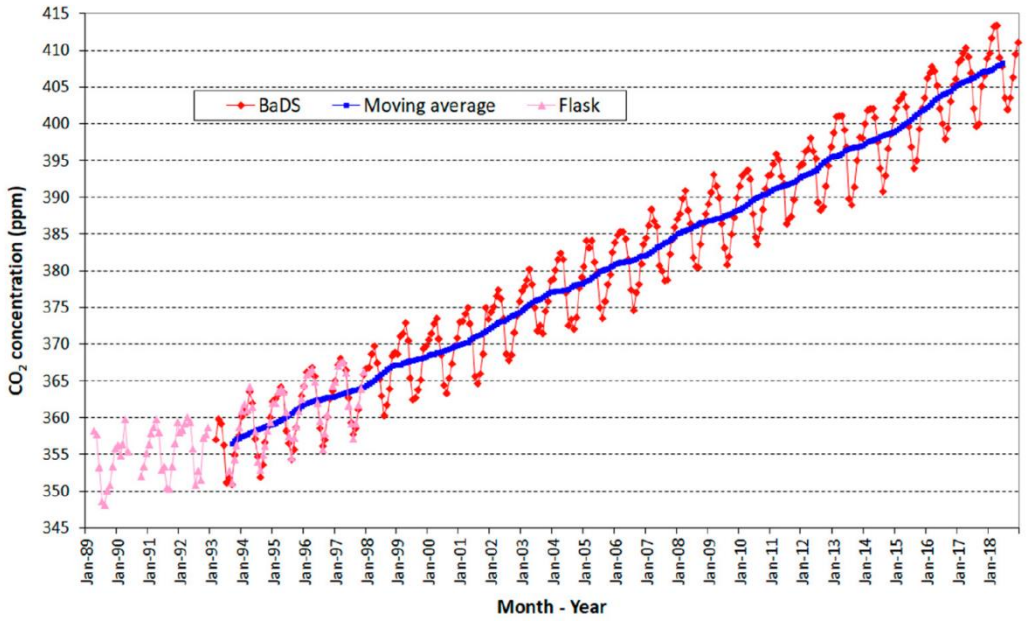
The literature explores public and industry views regarding the viability and environmental impact of the EVs; the affordability of EVs; and the extent of knowledge and familiarity of the use of EVs is presented.

As technology has advanced, the availability and variety of EVs has increased. Consumer's choice of EVs over ICE vehicles is based on their concern for the environmental impact of the transport system in contributing to CO2 emissions. EVs contribute economic benefits including employment opportunities in research and manufacturing. However, some research is sceptical of the take-up of EVs due to significant barriers including purchase price, running costs, fuel/charging infrastructure, driving range, and charging times (Marinov, 2019; Yousif & Alsamydai, 2019; Sivewright 2021).

Viability and Environmental Impact of EVs

EVs are more environmentally beneficial than ICE vehicles in that they emit less CO2 (Skippon & Garwood, 2011). EVs replace ICE vehicles that use high polluting fossil fuels, with lithium batteries for power that emit far less C02 emissions. In addition to environmental benefits EVs produce economic benefits such as employment opportunities in research and manufacturing, reductions in fossil fuel dependency, higher energy efficiencies, and an associated reductions in greenhouse gas emissions (Foley, Winning & O'Gallachior, 2010). EVs are also noted to have a significant impact on the engine noise in urban traffic (Ibarra, Ramirez-Mendoza, & Lopez, 2016).

Despite benefits from the use of EVs and despite the increasing number and variety of EVs available across the world, the vast majority of automobiles on the roads are still using ICEs. Roughly 90% of the sales of light vehicles in the US use ICE vehicles (Carlier, 2021) which are heavy contributors towards C02 emissions. Approximately 80% of CO2 is generated from the burning of fossil fuels such as coal, oil, and natural gas (Maximillian, Glenn, & Matthias, 2019). Apadula, Cassardo, Ferrarese, et al (2019) presents a time series of monthly C02 concentrations in the Plateau Rosa Alpine station in Italy. This time series depicts a 45% rise on CO2 between April 1989 and December 2018 (Figure 1).



(Figure 1) Apadula, Cassardo, Ferrarese, et al (2019, p.10)

Consequently, governments around the world legislated for reductions in all greenhouse gas emissions[3]. Notwthstanding legislation, challenges concerning the viability of EVs include range anxiety, charging speeds and battery life continue to plague the use of EVs (Dimitropoulos, Rietveld, & van Ommeren, 2013; Yuan, Hao, Su, et al, 2018; Long, Axsen, & Kormos, 2019; Secinaro, Calandra, Lanzalonga, et al, 2022). The Great Britain 2021 survey of the uptake of EVs reported a quarter of all energy consumers said that their household is likely to buy a PHEV in the next 5 years. The survey also reported that 45% of consumers are unlikely to buy an EV. This is an increase from the 38% reported in 2020. Reasons for the expected low participation rates is due to barriers such as concerns about range anxiety, a lack of charging infrastructure and battery life. Consumer preference surveys have also been conducted in Australia (Electrical Vehicle Council (2021), Canada (Clean Energy Canada, 2022) and Norway (Saele & Petersen, 2018).

Range anxiety is identified as one of the main reasons for consumers choosing not to purchase an EV. Range anxiety is defined as "a stressful experience of a present or anticipated range

[3] Refer to Law no. 2015-992 on Energy Transition for Green Growth (Energy Transition Law), France; Climate Change Act 2021, German Federal Government; Clean Air Act, United States, 42 U.S.C ch 85 (7401-7671q); Climate Change Act, 2018, Ministry of Climate and Environment, Norway.

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situation, whereby the range resources and personal resources available to effectively manage the situation (e.g., increase available range) are perceived to be insufficient" (Rauh, Franke & Krems, 2014: pg. 178). Drivers of battery EVs are reported as experiencing more range anxiety compared to drivers of ICEs (Yuan, Hao, Su, et al, 2018). High levels of range anxiety can potentially have negative impacts on the emotions of drivers of EVs. Survey results of range anxiety of drivers of EVs (Figure 2) concluded that the most common behaviour of drivers was speed reduction (46.6%) whilst the least behaviour taken was distracted by anxiety (12.5%).

TABLE 4: Statistics of driver's behaviors taken related to range anxiety.

Behavior	Distracted by anxiety	Rearrange the route	Seeking nearby charging-pile	Change behaviors	Speed reduction	Get more disturbed	Grab lines
Number of interviewees taking the behaviors above.	26 (12.5%)	40 (19.2%)	52 (25.0%)	70 (33.7%)	97 (46.6%)	47 (22.6%)	26 (12.5%)

(Figure 2) Yuan, Hao, Su, et al (2018, p. 6)

These results suggests that range anxiety can lead to more careful driving behaviour through a reduction in speed. Such findings contradict Yuan, Hao, Su, et al, (2018) previous position that high levels of range anxiety, battery and charging speeds can lead to dangerous driving behaviour. Research suggests that dealing with the range of BEVs in everyday use is not associated with experience but rather by the avoidance of range stress (Franke, Neumann, Bühler et al., 2012). Users of BEVs avoid critical range situations by adding a substantial range buffer. Franke & Krems, (2013) posit that the comfortable range is on average roughly 80% of a user's actual available range. Rauh, Franke, & Krems, (2015) suggest that experienced drivers reported significantly less range anxiety than inexperienced drivers.

The length of the recharging process is reported to significantly impact the viability of BEVs. It takes far longer to complete one single charge of an EV compared to the time spent filling up an ICE vehicle with petrol or diesel at a filling station. A typical EV with a 60kWh battery takes roughly 8 hours to charge from empty-to-full with a 7kW charging point (Pod Point, 2022). Despite this, there are multiple ways to charge an EV. Firstly, there are designated public charging points largely available in car parks around highly populated areas such as supermarkets, train stations and hotels. the accessibility of public EV charging points is critical. An EV must easily access a charging station within its driving range (Lam, Leung, & Chu, 2014). 92% of respondents to the Australian Consumer Attitudes Survey (2021) indicated that public charging infrastructure was an important factor in considering the viability of BEVs. 88% of respondents reported that home charging is also a consideration. This is to be compared USA and EU findings that home charging is the most preferable charging method for EV users.

Hackbarth, & Madlener, (2013) indicate that German BEV and PHEV drivers are willing to pay somewhere between roughly €5 and €18 for every saved minute in battery recharging time. Naturally, this is dependent of the purchase price of the vehicle plus the cost of train travel. Sivewright B., (2021) reported that about 59% PHEV drivers usually charged their vehicle at home. Interestly 25% of users charge their vehicle after every journey they make. Furthermore, 23% report that they only recharge when the battery gets low. Sivewright (2021) highlights that UK consumers hold concerns for the life of the battery. Consumer's resistance to

purchasing EVs relate to the battery range. The capabilities of particular EVs as shown in Figure 3 vary in terms of range (Speirs, Contestabile, Houari, et al, 2014).

BEV model	Battery energy (kW h)	Range (km)	Max speed (km/h)
Smart fortwo electric drive	16.5	140	100
Citroen C-Zero	16	130–160	130
PuegeotiOn	16	150	130
Mitsubishi i-MiEV 2012	16	150	130
Nissan Leaf	24	160	140
Renault Fluence Z.E.	22	160	135
Renault Zoe	22	160	135
Mia electric	12	120	100

(Figure 3) Speirs, Contestabile, Houari *et al* (2014, p. 186)

The 2021 UK survey results report that of the 45% of respondents who indicate they are very unlikely to purchase an EV, 32% indicate that this is due to concerns for a short battery life. In the 2020 Australian survey it is reported that almost 80% of respondents underestimated the driving range of an EV. Approximately 57% of respondents believe that a BEV had less than 300km driving range. A significant improvement in beliefs is reported in the 2021 survey results. Only 24% of respondents believe that an electric vehicle has less than 300km range on a full charge. Additionally, 35% of respondents considered that EVs can travel more than 400km fully charge. Indications from these survey results sees greater accuracy in consumers' perception of the driving range on a full battery charge. Furthermore, the current battery technology is sufficient to attain this kind of range (Skippon & Garwood, 2011). The availability of the charging station network decreases the risk of being stranded with an empty battery (Hackbarth & Madlener, 2013).

However, EV batteries are constantly improving as technology advances. "Since 2013, the estimated range for many EVs has increased significantly, for example, base models of the Nissan Leaf and Tesla Model S grew from 75 and 208 miles per charge in 2013 to about 107 and up to 249 miles in 2017" (Knupfer, Hensley, Hertzke et al., 2017: pg. 11).

Government incentives play a positive role in consumer choices of vehicles (Hackbarth & Madlener, 2013). However, in a survey of 21 U.S. cities (Krause, Carley, Lane, et al, 2013), about 95% of respondents were unaware of available incentives. Furthermore, a US study (Kurani, Caparello & Hageman, 2016). found that only 95% of respondents could identify two PHEV models, namely the Nissan Leaf or Tesla Model S. Such a result indicates low awareness about the range of available models. The UK Go Ultra Low campaign aims to increase public awareness of the benefits and capabilities of EVs as well as information concerning basic details on incentives. Consumer feedback from the 2016 campaign showed that 53% said the campaign increased their interest in EVs and indicated they would purchase one the next time they buy a car (Jin & Slowik, 2017). Indications are that consumers who possess knowledge or experience with the use of EVs are more likely to purchase EVs in the future and would be willing to pay a premium for the technology (Reiner & Haas, 2015).

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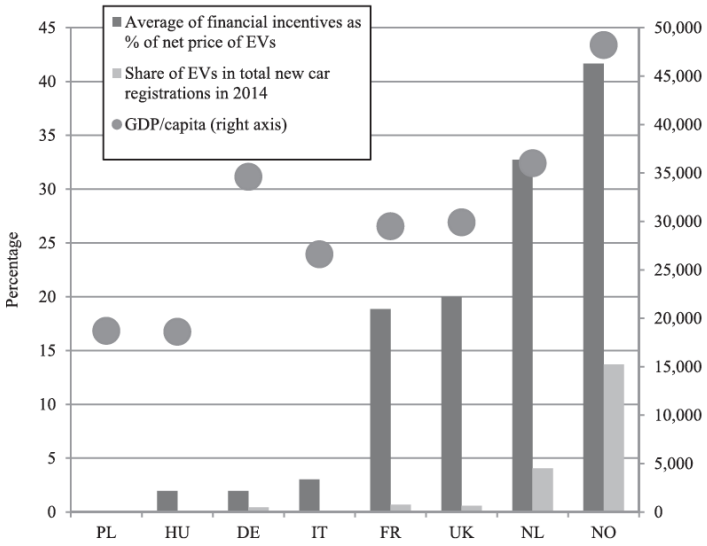
Hence, consumer awareness is an integral part of increasing EV uptake. As consumers become more aware of EVs as well as the charging infrastructure, it can be expected that public perceptions will be less of a barrier.

Affordability of EVs

The major factor against purchasing an EV is the high initial purchase price. It is common knowledge that EVs have a significantly higher initial purchase price compared to traditional ICE vehicles. Survey results of six European countries found that the EV purchase price is a a major deterrent to its purchase (Gomaz Vilchez, Smyth, Kelleher et al, 2019). Such price comparisons can burden the market introduction of EVs (Lebeau, Lebeau, Macharis et al, 2013). The second expensive component of EVs is the battery, which is expected to be between 18%-23% of the price by 2030 (Soulopoulos, 2017). Furthermore, a home charging point is expensive to acquire with an average cost between £800-£1,100 (Jackson, 2022). While home charging is a more practical alternative, the cost of electricity is charged through the owner's home electric bill.

Regardless of the initial purchase price of the vehicle, its battery and charging point, EVs offer significantly cheaper running costs. The 2013 U.K. Energy Savings Trust statistics report that EVs offer significantly cheaper running costs. Savings to be made is calculated by comparing a battery charging cost of roughly £2 to £3 for a range of 100 miles with approximately £12 to £18 for petrol or diesel car to drive an equivalent 100 miles (Bunce, Harris & Burgess, 2013). Furthermore, over a period of 4 years, consumers could potentially save 43% from powering an EV compared to refuelling an ICE vehicle (Levay, Drossinos, & Thiel, 2014). Additionally, Soulopoulos (2017) suggets that base vehicle costs, for example, body and chassis, is expected to decrease due to simplified designs and more efficient manufacturing. Furthermore, owners of EVs will experience significant long-term savings in the form of road taxes, insurance, non-use of fossil fuels, and incentive schemes from the government. To the consumer, however, despite the convenience of home charging, and estimated long-term cost savings, the high initial purchase price is a discouragement to buying an EV (Bunce, Harris, & Burgess, 2013).

To encourage consumers to move away from the traditional ICE vehicle to the use of EVs which reduce CO2, governments in the UK and around the world have introduced incentive schemes to encourage the use of EVs. Government incentives encourage, for example, the acceleration of deployment of Plug-in Hybrid EVs technology which is estimated to reduce petrol costs and incentives for producing ultra-low emission vehicles (Simpsons, 2006). Unfortunately, such incentives are not considered cost-competitive and have little significance to the overall cost of purchasing an EVs. Despite these incentives, the UK falls behind comparable European countries as shown in Figure 4. Norway, for example, is arguably the most progressive country in Europe in terms of the integration of EVs (Levay, Drossinos & Thiel, 2017).



(Figure 4) Levay, Drossinos, and Thiel (2017, p.525)

Figure 4 hightlights the average financial incentives available for EVs in eight European countries: Poland, Hungary, Denmark, Italy, France, United Kingdom, the Netherlands, and Norway. The data clearly shows that Norway have significantly higher results in terms of average fiscal incentives as a percentage of the net price of EVs and share of EVs in total new car registrations in 2014. Norway appears to be paving the way for efficient integration of EVs in Europe. For the UK to compete with their European neighbours, they must improve the available government incentive schemes to match that of Norway.

It is UK's responsibility to reduce their C02 emissions and efficiently integrate the use of EVs. It needs to encourage consumers to purchase EVs to help reduce C02 emissions and meet their environmental targets. The environmental benefits of EVs, and the environmental impact of ICE vehicles has been clearly articulated in the literature. However, there are still many challenges related to the viability and affordability of EVs, including high initial purchase prices, expensive batteries, and limited range of models, which could disrupt the easing of EVs into everyday society. There is evidence to suggest that a reduction in the overall price of EVs, particularly the purchase price, will encourage consumers to choose EVs over traditional ICE vehicles. Consumers must ensure they research EVs thoroughly before purchasing, either for personal or business use, to maximise their savings.

Knowledge and Familiarity of the Use of EVs

Several studies have found that there is a general lack of knowledge and awareness by consumers about EVs. An IBM consumer survey (Gyimesi & Viswanathan, 2011) found that 45% of the surveyed drivers had little to no understanding of EVs. Consumers are hesitating about purchasing EVs, largely due to their unfamiliarity with the EV technologies. A study by Kannstatter & Meerschiff (2015) in Europe found that 71% of participants expressed interest in considering an imminent purchase of an electric vehicle after a test drive.

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Consumers with greater knowledge about EV technologies are more likely to embrace EVs. The more consumers understand the technology, availability, and the use of electric and hybrid vehicles, the more likely the intention to purchase will evolve (Wang, Fan, Zhao, et al, 2016). To promote the take-up of EVs, how consumers perceive EVs and what the possible barriers against this take-up must be understood (Singh, Singh, & Vaibhav, 2020). Research notes that the consumers who are not comfortable with technology will have negative perceptions of its ease of use and the usefulness of EV technology (Mwasilu, Justo, & Kim, et al., 2014).

Hence, when consumers understand that EVs are simpler and more convenient to use and more beneficial to the environment they will show a greater willingness to buy such vehicles.

RESEARCH METHODOLOGY

The aim of this research is to gain knowledge of the public opinions of EVs. The methods outlined are chosen to ensure the results give an accurate reflection of the public's view of EVs. A mixed methodology to this research is used (Flick 1998). The research employs a case study to gather data through a combination of quantitative and qualitative data. According to Creswell (1999, p. 455) "a mixed method study is one in which the researcher incorporates both qualitative and quantitative methods of data collection and analysis in a single study. Creswell elaborates (p. 455) and says that this type of study allows the researcher to "understand complex phenomena qualitatively as well as to explain the phenomena through numbers, charts, and basic statistical analysis."

Qualitative data is collected via questionnaires and interviews. A questionnaire was devised using Microsoft Teams and sent out to the general public. Three interviews were conducted with 2 participants being interviewed together. The interviewees include established long-serving employees within the automotive industry and an EV owner. The interviews allowed the researcher to gain further knowledge and understanding of the topic and allowed the interviewees to share their own personal views on EVs.

The timing of the research undertaken was an important factor to consider in order to obtain satisfactory results from the questionnaire and interviews. Saunders, Lewis, & Thornhill (2007b) refer to the time taken for research as the time horizon. Cross-sectional study refers to research conducted under certain time constraints, which is most commonly used for research carried out over a short period of time (Melnikovas, 2018). The research was conducted over a six-month period between October and March of 2022. Therefore, a cross-sectional approach will be adopted.

The research was carried out using a mixed method approach, where both qualitative and quantitative data must be considered. Weighting refers to the priority given to the qualitative and quantitative data when doing the research. The decision to prioritise either the qualitative data or the quantitative data lies with the research. In this study, the qualitative data and quantitative data will receive equal weighting as they are of equal importance.

Sampling is a "subset of the population, selected so as to be representative of the larger population (Acharya, Prakash, Saxena, 2013: pg. 330). Due to time constraints and resources, a sample is used to obtain data from a small section of the population in order to gain as much relevant data as possible. The questionnaire was sent out to the general public and employees

in the automotive industry. Similarly, interviews were conducted with established members of the automotive industry and a member of the public that owns an electric vehicle.

It is crucial that each individual is able to share their responses anonymously to allow for complete accuracy. Therefore, a survey strategy was used by create an anonymous questionnaire (Babbie, 1990). A simple questionnaire was produced asking participants questions related to EVs. The questionnaire was created using Microsoft Forms and was distributed remotely to students and staff at a university, friends, family, users of social media, and to staff members at Company A (one of the UK's largest car retailers). 130 responses were received. The data from the responses were key to gaining knowledge and understanding of the study.

For this type of study, questionnaires are a useful tool and provide many advantages for the researcher. Wright (2005, p. 2) posits the advantages include "access to individuals in distant locations, the ability to reach difficult to contact participants, and the convenience of having automated data collection, which reduces researcher time and effort." Questionnaires are also easy to create, and in the case of this study, only required access to the internet and Microsoft Forms. To ensure the willingness of participants to give up their free time without any personal gain, the questionnaire was an appropriate length of 12 questions. The questionnaire begins with simple demographic questions followed by more specific questions related to EVs, including the viability of EVs, the affordability of EVs, and knowledge and familiarity of the use of EVs.

A semi-structured approach to interviewing was chosen. This approach was chosen to allow as much information as possible to be shared from the interviewee. If the interviewee is answering a question and goes off-track, a semi-structured interview allows the interviewer to access new and relevant information they may not have been accounted for (Longhurst, 2003).

A crucial part of the research was to interview individuals that held senior positions within the automotive industry and had significant knowledge and experience with EVs. In addition to this, an EV owner was interviewed to grasp an overall understanding of their experience with EVs to date. All interviews were conducted in person, allowing for an informal and comfortable environment when conducting the interviews. The interviews varied in duration, with the shortest interview lasting just under 25 minutes, and the longest interview lasting just over 40 minutes. To allow for preparation, a copy of the questions to be asked was emailed to the interviewees, along with some brief details of the study. Each interview contained some questions that were tailored to each interviewee for relevance to the study. The interviews were voice recorded and then transcribed to enable a naturally flow of conversation without the interviewer having to stop to take detailed notes.

Presented below is a list of the interviewees and details of their relevance to the study. The interviews were carried out in March 2022. Each interview was set up through verbal communication and email, with an agreed date, time and location for the interview.

1. Participant A (P1) who has a vast knowledge of the automotive industry having worked in the industry for over 20 years.
2. Participant B (P2) who is an EV owner and offered to share his experience after receiving the questionnaire.

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3. Participant C (P3) who is a Manager at Company A.
4. Participant D (P4) who is considered an Innovation Genius at Company A.

Ethics guidelines provided by the University of the West of Scotland were followed throughout this study. The participants who took part in the questionnaire were given a briefing on the topic of the research, and an explanation that the questionnaire results are completely anonymous. In addition, it was stressed that the participants can withdraw their responses at any time during the survey.

For the interviews, the interviewees were given a copy of the questions that would be asked along with a consent form. It was also explained that the interview would be semi-structured, therefore, other questions may arise during the interview process. Similar to the questionnaire, it was stressed to participants of the interview that they can remove themselves from the interview at any time. The interviewees also had the choice to share their details or remain anonymous.

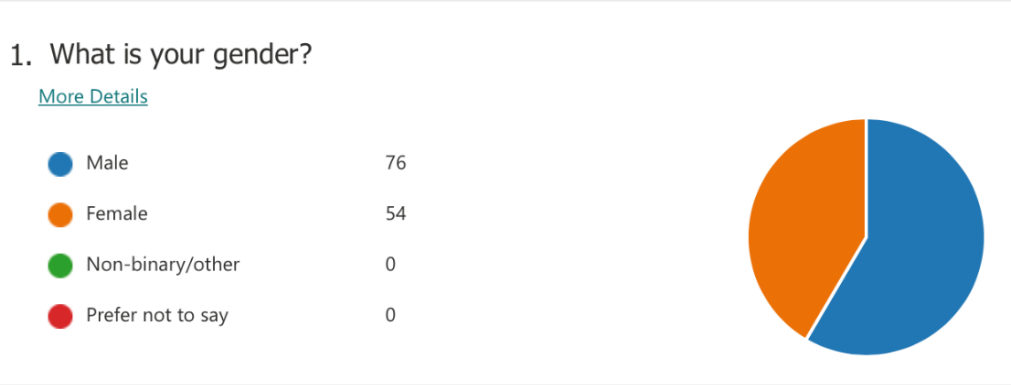
The questionnaire allowed the participants to share their views and experiences with EVs, whereas the interviews enabled an understanding of the knowledge of individuals who had experienced EVs in their daily lives, whether it be owning an EV, or EVs are a huge part of their employment.

RESULTS AND DISCUSSION

An analysis of the data collected from the questionnaire is presented using graphs and charts from Microsoft Forms.

Questionnaire Results

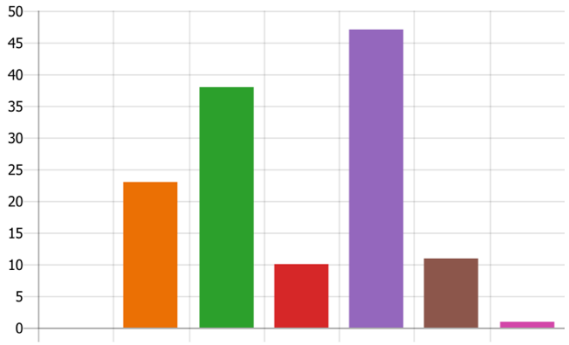
Questions 1-4:



2. What is your age?

More Details

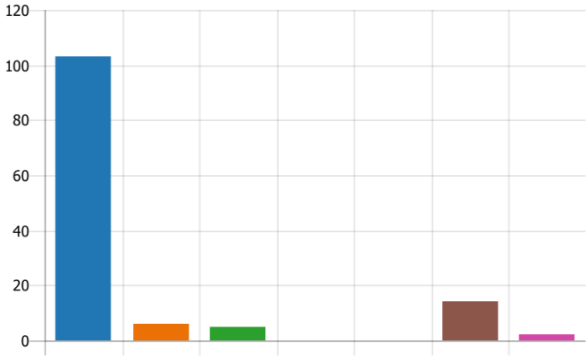
Under 18	0
18-24	23
25-34	38
35-44	10
45-60	47
60+	11
Prefer not to say	1



3. What is your employment status?

More Details

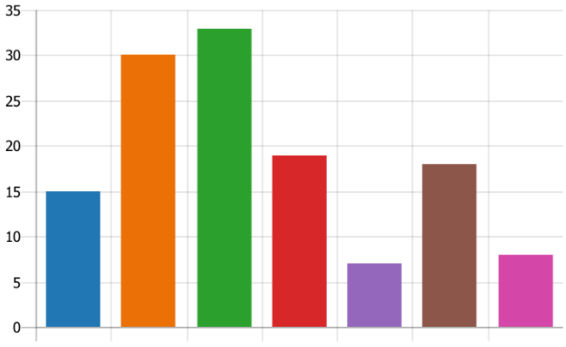
Full-time	103
Part-time	6
Full-time Student	5
Part-time Student	0
Unemployed	0
Other	14
Prefer not to say	2



4. What is your annual income?

More Details

Less than £15,000	15
£15,000 - £24,999	30
£25,000 - £34,999	33
£35,000 - £44,999	19
£45,000 - £55,000	7
Over £55,000	18
Prefer not to say	8



The questionnaire begins with 4 simple questions to gain an understanding of the demographic of the participants. Question 1 reveals that of the 130 responses, 76 (58%) were male and 54 (42%) were female. The highest represented group was aged 45 – 60, with 47 of the 130 responses (36%). The option that received the least number of responses was the 35 – 44 age group, with 10 (7.7%).

Interestingly, of the 130 responses for Question 3, 103 (79.23%) of the participants were in full-time employment. This high percentage is due to the questionnaire being sent to staff

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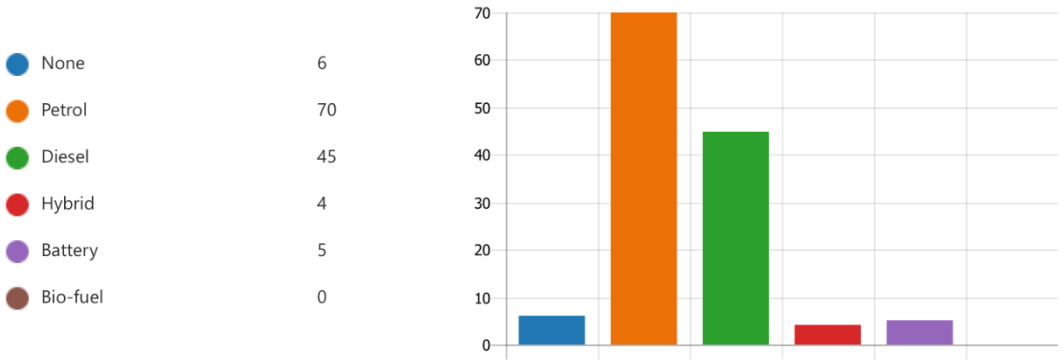
members in the automotive industry. Part-time employment received 6 responses, full-time student received 5 responses, and 2 participants preferred not to share their employment status. There were also 14 participants that chose the option 'other'.

Question 4 asks the participants their annual income. The option that received the highest number of responses was '£25,000 - £34,999' group, which received 33 (25.38%) responses. The last chosen option was for those who earn between £45,000 and £54,999, with 7 (5.38%). 'Less than £15,000' received 15 responses (11.54%), '£15,000 - £24,999' received 30 responses (23.1%), and £35,000 - £44,999 received 19 responses (14.62%). 8 participants (6.15%) chose not to share their annual income and the option with the highest annual income (over £55,000) received 18 responses (17.48%).

Question 5-7:

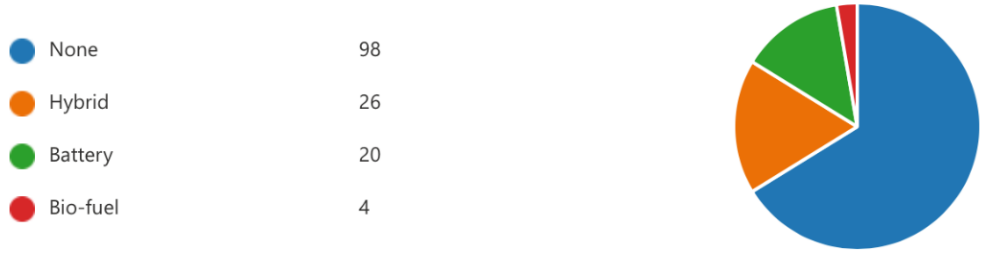
5. What type of vehicle do you own?

More Details



6. Do you have any experience with alternative energy vehicles? Select all that apply

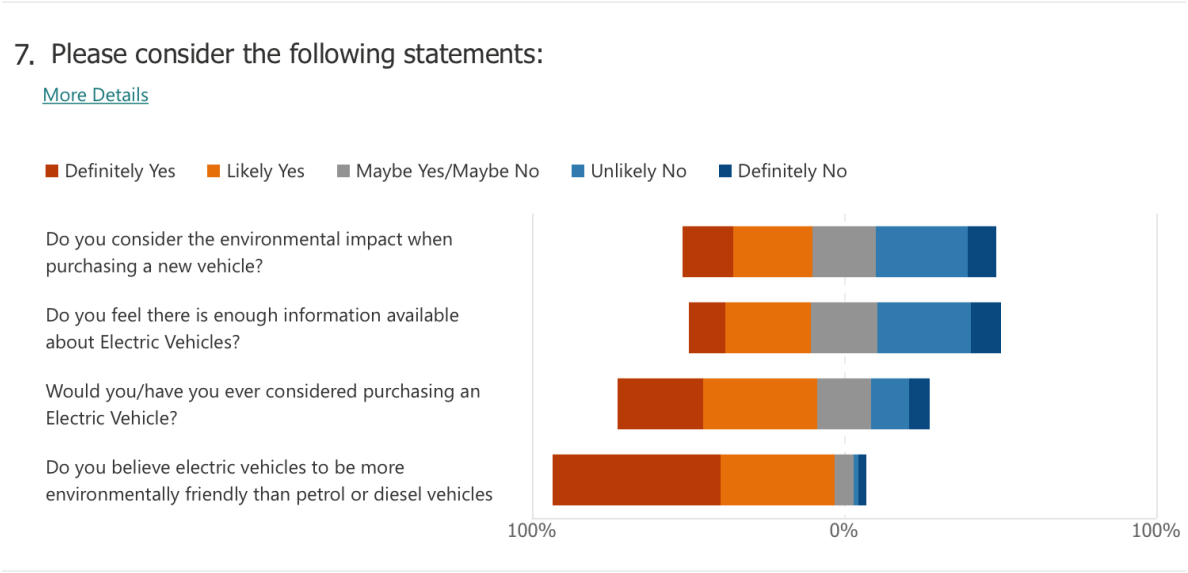
More Details



Question 5 and 6 from the questionnaire are more specific to the individual regarding EVs. Question 5 seeks information about the type of vehicle participants own. Unsurprisingly, of the 130 responses, the most popular option was 'petrol' with 70 (53.85%). This was followed by the second most popular option 'diesel' with 45 responses (34.62%). These results support the findings of Carlier (2021) who reported that roughly 90% of the sales of light vehicles in the US use ICE vehicles. Only 9 (6.92%) of the participants own an EV, with 5 (3.85%) owning a battery powered EV, and 4 (3.08%) owning a hybrid EV. 6 (4.62%) of the participants do not own any form of vehicle.

Question 6 sought participants experience with EVs. It asks the participants if they have had any experience with several different electric vehicles. 90 (69.23%) said they have no

experience with an EV. This finding supports the indications of Reiner & Haas, (2015) and Wang, Fan, Zhao, et al, (2016) who argue that consumers who possess little experience with the use of EVs are more hesitate about purchasing EVs. The more consumers understand the technology and the use electric and hybrid vehicles, the more likely the intention to purchase will evolve. The EV that the participants have had the most experience with is Hybrid EVs, with 26 (20%), whilst 20 (15.38%) said that they have had experience with a battery powered EV. Singh, Singh, & Vaibhav, (2020) suggests the necessity to promote the take-up of EVs, how consumers perceive EVs and what the possible barriers against this take-up must be understood (Singh, Singh, & Vaibhav, 2020).



Question 7 asks the participants specific questions regarding the purchase of an EV. When considering the environmental impact of a vehicle when purchasing a car, 16% answered "definitely yes" and 25.2% answered "likely yes". However, 20.6% answered maybe yes/maybe no, 29% answered unlikely while 9.2% answered no. The literature suggests some encouraging signs that the environmental impact of vehicles is a consideration for consumers hoping to lower their own C02 emissions. However, responses to the questionnaire indicate that the environmental impact of vehicles is not much of a concern.

The second question asks participants if they consider there is enough information available about EVs. Of the 130 responses, 11.5% answered "definitely yes" and 27.5% answered "likely yes". Whilst 21.4% answered "maybe yes/maybe no", 29.8% answered "unlikely no" and 9.9% answered "definitely no". This shows a roughly even split on whether participants felt there was enough information available on EVs. Several studies have found that there is a general lack of knowledge and awareness about electric vehicles (Singer, 2015; Kurani & Tal, 2014; Jin & Slowik, 2017). The findings of this questionnaire reported better survey results than that found by Gyimesi & Viswanathan (2011) who found that 45% of the surveyed drivers had little to no understanding of EVs. Regardless, it is posited that consumers are hesitate about purchasing EVs largely due to their unfamiliarity with the EV technologies.

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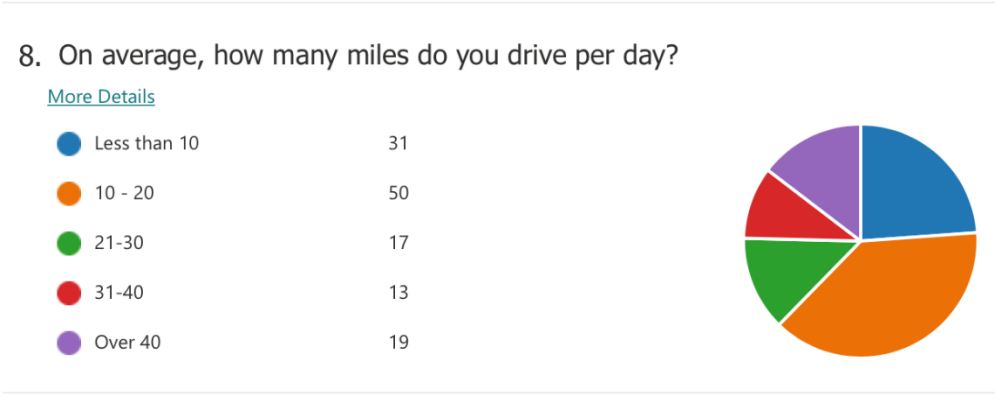
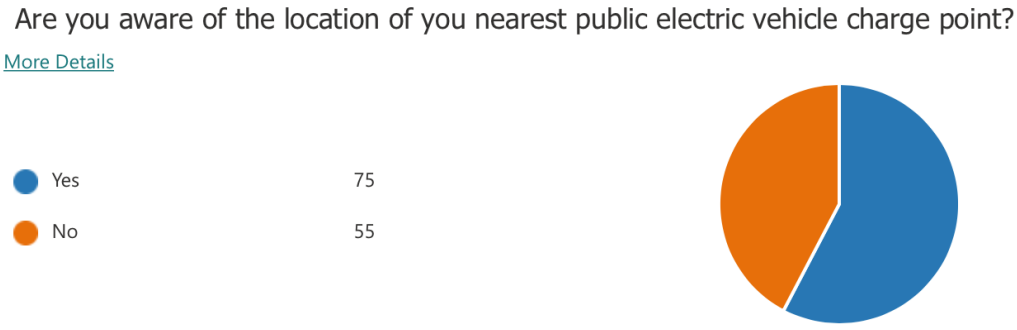
The third question shows encouraging information. The question asks participants would you/have you ever considered purchasing an electric vehicle. Of the 130 responses, 27.5% answered "definitely yes" and 36.6% answered "likely yes". This shows that the majority of those surveyed have considered the purchasing an EV, despite the high initial cost. 16.8% answered "maybe yes/maybe no" and unfortunately, 12.2% answered "unlikely no" and 6.9% answered "definitely no". As consumers gain more experience driving an EV, they show more favorable attitudes towards purchasing one. This position is supported by a study by Kannstatter & Meerschiff (2015) in Europe found that 71% of participants expressed interest in considering an imminent purchase of an electric vehicle after a test drive. In another study Bunce, Harris & Burgess, (2014) as consumers become exposed to government led campaigns designed to raise awareness of the features and viability of EVs more potential drivers are willing to consider the purchase of a more environmentally friendly EV.

Questions 8-9:



Of the 130 responses to Question 8, the most popular response was 10 - 20 miles, with 50 (38.46%). 31 (23.85%) responded less than 10 miles, 17 (13.08%) of the participants drive 21 - 30 miles per day, 13 (10%) said they drive between 21 and 40 miles, and 19 (14.62%) said they drive over 40 miles per day. Interestingly, 98 (75.38%) of participants drive no more than 30 miles per day on average. Yet some EVs, for example, the new 2021 Lexus UX300e can travel up to 196 miles on a single charge, according to their website (Lexus, 2022). From these responses it is clear that the distances travelled will be sufficiently supported by the current battery technology (Skippon & Garwood, 2011).



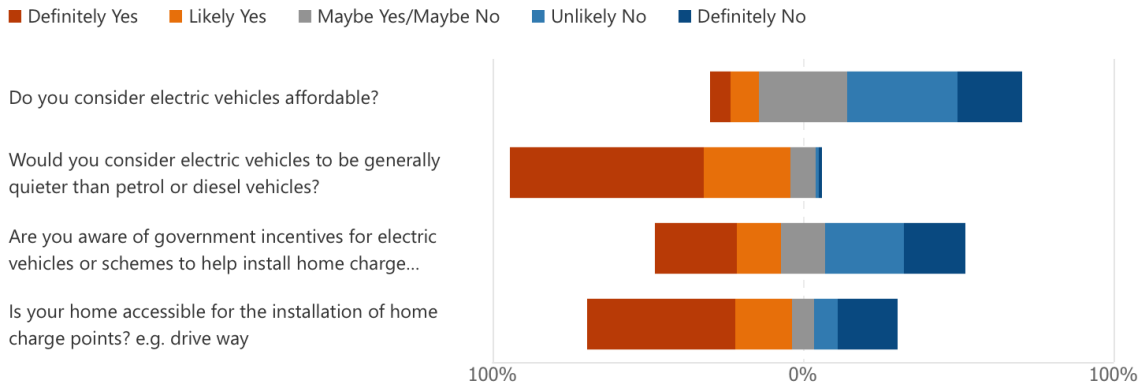
Question 9 refers to the participants' knowledge of their local EV charge points. In recent years, EV charge points have become more accessible to the public in many highly populated areas

such as supermarkets and train stations. Schultz & Rode (2022) highlights the importance of improved charging infrastructure. According to Hackbarth & Madlener (2013) the availability of the charging station network decreases the risk of being stranded with an empty battery.

Questions 10-12:

10. Please consider the following statements:

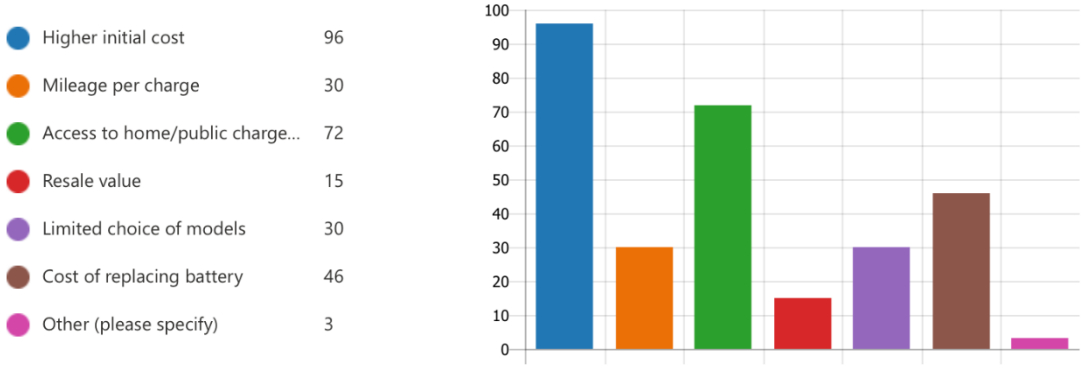
More Details



Question 10 seeks participants personal views on EVs. Responses to the first statement reflects the literature's reporting of the general opinion of EVs. When asked if the participants consider EVs affordable, only 6.2% said definitely yes, and only 9.2% said likely yes. This data echoes the view of Lebeau, Lebeau, Macharis et al, (2013) who highlights that EVs generally sell at higher prices than petrol and diesel vehicles. 28.5% said maybe yes/maybe no which could be a reflection of a poor understanding of EVs as a result of a lack of information from the automotive industry and/or government. 35.4% said unlikely no, and 20.8% said definitely no. This data shows that the majority of the participants are of the opinion that EVs are not affordable to them. With this, and the high percentage of participants choosing the option maybe yes/maybe no, it could suggest that the participants do not have great general knowledge of EVs, however, they are aware EVs are too expensive for them to afford. However, Participant 4 believes there are considerable savings to be made from an EV. Price consciousness influences EV purchase intention (Cui, Wang, Chen et al., 2021).

11. What is you biggest concern regarding electric vehicles? Select all that apply

More Details



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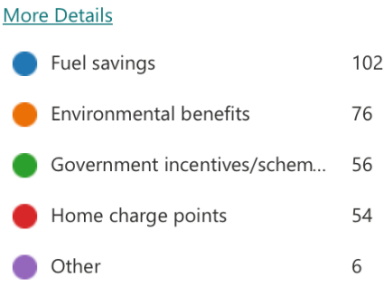
Other (please specify) responses include:

- Re-charge time
- Running cost
- Battery concerns related to weather conditions

Question 11 gives the participants an opportunity to share their biggest concerns regarding electric vehicles. Participants chose multiple options, as out of 130 participants, there were a total of 292 responses to this particular question, with the most common responses chosen being related to the cost of EVs. The overall biggest concern was the higher initial cost of EVs with 96 (32.87%) responses. Literature covering EV demand has recognized a wide range of issues which have the potential to affect how consumers form opinions of and preferences towards EVs. Factor inhibiting EV demand generally relate to the functional characteristics of EVs, namely, up-front price, cost of battery, and battery charging (Morton, Anable, & Nelson, 2016; Sivewright, 2021).

12. What are the main factors that would influence you to purchase an electric vehicle? Select all that apply

More Details



Other responses highlighted include:

- Overall Price
- Speed
- Lower maintenance cost x2
- Less noise pollution
- Public charge points

Question 12 highlights some positive factors related to EVs and ask participants if any of these factors would influence them to purchase an EV. Of the 130 participants, this question received 294 responses. The most popular response was fuel saving, with 102 responses (34,.69%). As petrol & diesel prices rising, consumers have been forced to look for alternatives and EVs offer a cheaper alternative to ICE vehicles in terms of charging compared to refuel an ICE vehicle. Asadi, Nilashi, Samad, et al (2021) finds that EVs can lead to a 40% to 60% increase in fuel efficiency than vehicles that rely on conventional fuels (Asadi, Nilashi, Samad, et al., 2021).

Questionnaire findings support the literature regarding public views regarding the viability of EVs including range anxiety, charging speeds and battery life which continue to plague the use of EVs (Dimitropoulos, Rietveld, & van Ommeren, J. N., 2013; Yuan, Hao, Su, et al, 2018; Long, Axsen, & Kormos, 2019; Secinaro, Calandra, Lanzalonga, et al, 2022).

Questionnaire results relating to the views around the affordability of EVs including the initial purchase price, expensive batteries, and cost of home charging points could disrupt the easing of EVs into everyday society (Lebeau, Lebeau, Macharis et al, 2013; Bunce, Harris, & Burgess, 2013; Soulopoulos, 2017; Gomaz Vilchez, Smyth, et al, 2019).

Findings of the questionnaire regarding public knowledge and familiarity of the use of EVs indicate that consumers who have little to no understanding of EVs are hesitate about purchasing one (Kannstatter & Meerschiff, 2015). The more consumers understand the technology, availability, and the use electric and hybrid vehicles, the more likely the intention to purchase will evolve (Wang, Fan, Zhao, et al, 2016).

Interview Results

Interviews were conducted to add a richness of information that underlies the questionnaire findings. The interviews were carried out over the academic year and were all conducted in person. Similar to the questionnaire, the interviews begin by asking the interviewee simple personal questions, including their name, job title, followed by more specific and detailed questions related to EVs and their experiences with EVs. The demographics of the interviees are presented in Table 1.

Table 1: Demographics of Interviewees

Participant	Gender	EV Relevance	Interview Duration	Location	Date
P1	Male	Head of Business Company A	25 minutes	Residence	10/3/22
P2	Male	EV Owner	25 minutes	Residence	11/3/22
P3 & P4 jointly	1 Female 1 Male	Manager – Company A Innovation Genius for EVs – Company A	40 minutes	Company A	17/3/22

Viability of EVs

Questions posed to Interviewees regarding the viability of EVs produced the following typical responses.

What was your biggest concern about buying an EV?

"I'd say the range. It's perfectly fine for a couple hours here and a couple hours back because our car has a range of about 175 miles. And that's if you don't put the radio, air conditioning on, all that stuff."

What do you think puts people off purchasing an EV?

"I would say three things (upfront cost, range, or charging) are the top three reasons why people won't buy. If I had to put them in order, I'd say that range anxiety is definitely the biggest one. At the start EVs were only getting around 50, 60 miles, but now they can do around 200 to 300. If someone is planning out a journey, they must plan on when they're going to stop and charge, and they need to find out where that will be possible. The charge points aren't as available as petrol stations, so they need to look at infrastructure. Now if they're on the motorway, a lot of the charging points are in motorway service stations, but not everyone will

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use them, they might be travelling on A and B roads where there isn't the option to recharge. So until the infrastructure is better, then it's always going to be an issue."

What are the main advantages/benefits of owning an EV? Either for personal or business use?

"From the business point of view. There are huge benefits for company car drivers. Right now, a petrol car as a company car, you'll pay something like 23% tax on that, but for an EV right now its 1%, so there's a massive different there. So, for a business owner to switch to electric, there's a massive cost saving to be made from it."

Do you think the public consider the environmental impact when purchasing an ICE or EV vehicle?

"Yeah, some of the language from our visitors suggests that they know a lot about EVs already. They tell us they're reading about it and they're seeing it on the news. I've spoken to many who know about the 2030 deadline for manufacturers producing new ICE vehicles. Traditionally, people change their car every 2 or 3 years so they are coming to us and saying that they're better just changing to an EV now."

Many people still worry about range anxiety related to EVs. Do you have any advice for those that suffer that could help put their mind at ease?

"…When the Nissan leaf came out in 2012 there was range anxiety with that. But now the EVs are averaging around 300-mile range, and I can't remember the last time I made a 300-mile journey. It's all about how you drive the cars. With petrol cars you fill your car for 5 minutes and you're away. The difference with an EV is that you can get a rapid charge, or you can charge it overnight for 7 or 8 hours in your driveway. So, it's just a bit of a lifestyle change. I think that range anxiety is a preconception from people that have had bad experience with EVs in the past, but like everything, they're constantly improving."

When you buy an EV with Company A, or even if you have your own knowledge of this, do you actually own the battery?

"You can finance the battery, as well as the car. However, the batteries on their own are extremely expensive, some of them go for over £10,000, so most of the time the customers will finance it as a lot of people don't just have ten thousand pounds sitting. And a lot of people don't know about the breakdown of costs for EVs."

Where does most of your charging occur? What made you get a home charge point over using public charge points?

"I would say its 50/50. 50% at home, and there are a few local ones that we use, train station, car parks etc. Some of them are free too. The only downside to these is that they don't always work. They're quite temperamental."

"There are plenty of charge points in the network. A great fact we have on the wall is that there are more charge points in the UK than there are petrol stations. But what I would say, it's important that the infrastructure keeps up with the demand for EVs because it's constantly increasing."

Questions posed to Interviewees regarding the affordability of EVs produced the following typical responses.

Was the cost benefit a deciding factor over purchasing a petrol or diesel vehicle?
"I wouldn't say it was the deciding factor. There were some elements of the cost saving that helped but there wasn't a huge saving. It was more just wanting to go electric and not having to use fuel and be more eco-friendly really. I'd say we were saving around 30% compared to filling up with petrol and diesel so I'd say it was more about being more eco-friendly than the cost benefit."

EVs tend to have a higher purchase price compared to ICEs. Is there any way that you as a company help with that?
"…One thing I would add to that is that there is far fewer moving parts in an EV so there's far less to go wrong. Of course, you'll be paying a premium for not having to worry about many things going wrong shall we say, so there's also huge savings to be made for maintenance costs." A lower initial cost, or general lowering of EV prices could encourage lower income individuals to purchase an EV.

Did you use any government incentives? And were they a reason for looking into EVs in the first place?
"We were lucky. Our brokers were doing a deal that the government were paying for half of the charge point in your house, and the deal was that Audi, through the broker, were paying the other half so we got a home charge point for nothing."

When you were doing your research, was the high upfront cost something that you had to think about?
"Well for us, we done it through hire purchase. We just explored the best cost for us and we managed to get a deal through a one-month payment. With hire purchase you can do one-month, three-month, six-month, even nine-month payments. I was warned about the high upfront cost at the start, but we found it to be quite flexible. If there wasn't an option to do that it might have given us more to consider."

Questions posed to Interviewees regarding knowledge and familiarity of the use EVs produced the following typical responses.

Do you feel, as someone in the industry, that there is enough information available about EVs?
" I do think the manufacturers are doing their bit for advertising. Well, to give an example, if you watch the TV any time just now, any advertising for a car you see now will be for either a fully electric, or a hybrid vehicle. You'll very rarely see an advert for an ICE vehicle."

"I think since the beginning of covid in early 2020, when the manufacturers closed their factories, I think they looked and said what's the point of us investing millions and millions of pounds into new petrol or diesel vehicles. I think they said let's look to the future and go for EVs whether it be full electric or hybrid vehicles, so I have seen a spike in sales of EVs. I've also noticed a lot more people ask me about EVs when I'm not at work and just casually enquiring about them more often."

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What motivated you most to use an EV?

"It was a mixture of a lot of things, the environmental benefit definitely, more so probably my wife. For me it was mostly the convenience. You don't have that hassle of going to petrol stations because I can charge it at home. I like the design of them as most of them are all new designs. I like the way they drive, it's nice and quiet. So, the performance, look, feel, as well as the environmental benefit. So, once you marry that altogether it was a no-brainer."

While the interviewees are selected from a very small sample and cannot be considered members of the general public, the typical responses provide a depth of information that provides an understanding that underpins the findings of the questionnaire.

The research collected and analysed highlights the differing views from participants on the questionnaire and the interviewees on EVs. Despite the positive factors related to the EVs, including the environmental benefits, the data collected and analysed suggests that there are still too many negative factors involved for consumers to consider for buying an EV over an ICE vehicle. The high initial purchase price, especially for those on low income, is too expensive, even after considering the government incentives/schemes. Many of the participants in the questionnaire believe that there is not enough information available about EV and their benefits over ICE vehicles. Lower initial purchase price, whilst improvements in manufacturing, for example, more government incentives/schemes, increased range, high efficiency batteries, and improved charging infrastructure could allow more people to purchase EVs and lower carbon emissions in the UK.

CONCLUSION

Although EV technology is consistently improving, there are still many negatives associated with it. This has been highlighted throughout this study in the literature review and in the results obtained from the questionnaire and the interviews. The environmental benefits associated with EVs are clear, however, it remains to be seen if they can become a legitimate competitor to petrol and diesel vehicles. Despite the government's attempt to encourage the integration of EVs, some believe that it is too late, and it will take a considerable amount of time for EVs to become the most common vehicles on the road.

In general, the views on EVs are mixed as there are still many concerns associated with the vehicles, including range. However, in recent years, the range capabilities of electric vehicles have dramatically increased, with some being able to travel up to 300 miles on a single charge. In addition to this, the variety of EVs available has never been higher. Due to government legislation, manufacturers have shifted their focus from traditional petrol/diesel vehicles to EVs, allowing for more variety of models and improved technology. The use of fossil fuels in the 20th century has had a disastrous impact on the planet, including the emissions produced in petrol and diesel vehicles. Therefore, due to the environmental benefits, electric vehicles can be considered a viable replacement for petrol and diesel vehicles.

Currently most EVs are new and very costly. They do not have similar low production costs compared to ICE vehicles. In addition to this, there is not a big enough used electric car market for them to be considered affordable. However, with rising price of petrol and diesel, and an imminent ban on the production of ICE vehicles in the UK by 2030, consumers have been forced to look at alternative fuel vehicles, including fully electric and hybrid vehicles. There is huge

potential for electric vehicles, however, until the high initial cost decreases, it would be difficult to argue that EVs are affordable, even with the long-term savings associated with them.

Throughout this study, the positives and negatives of EVs have been highlighted. The environmental benefits of EVs are arguably their most notable positive, as they emit extremely low emissions into the atmosphere, and charging the vehicle requires electricity, which is a renewable energy source, compared to petrol and diesel vehicles that use harmful fossil fuels. Additionally, there are various cost savings related to EVs, including road tax, insurance, and government incentives. It is argued that the long-term savings from owning an EV outweigh the high initial purchase price, as charging an EV is generally cheaper than refuelling an ICE vehicle. Despite the positives, there are still many negatives associated with EVs. In general, EVs cost more than ICE vehicles, particularly the initial purchase price, an argument that has been backed up in the literature review and the results chapter. Furthermore, charging an EV takes significantly longer than re-fuelling an ICE vehicle. Consumers tend to charge their vehicle overnight, which can take up to 6-7 hours for a full charge. Range anxiety is still a major factor for consumers. Despite the technology improvements, EVs are still not capable of travelling the same distances as petrol or diesel vehicles. Many argue that there are still too many negatives associated with EVs for them to become genuine competitors to petrol or diesel vehicles.

It is important that enough information regarding EVs is available to the population, including information about the environmental benefits of EVs, information, infrastructure, charging, and the cost benefit of EVs. Also, more funding for charging infrastructure is required. One of the most common negatives related to EVs is charging. There must be more available charging points, particularly in rural areas, for EVs to become the most common vehicles on the road. Finally, the overall price of EVs must be reduced. If the price remains high, those on low incomes will not be able to afford them. There must be a range of affordable EVs produced to efficiently integrate electric vehicles into society.

LIMITATIONS

Throughout this study, limitations were identified. Firstly, the questionnaire was sent out to the public and to those who worked in the automotive industry. With the benefit of hindsight, it may have been more beneficial for the study if two separate questionnaires were created: one sent out to the public, and one sent out to individuals that are employed in the automotive industry. This would have given the researcher a clearer image of the views from the two groups.

Furthermore, it was difficult to gain access to literature related to EVs in the United Kingdom. There are many sources available from other European countries, especially in Norway, who are leading the way in EV integration and infrastructure. However, it may have been beneficial for the study to have access to more information regarding EVs in the UK to gain further knowledge of EVs closer to home.

FURTHER RESEARCH

Due to the overwhelming majority of the respondents to the questionnaire not owning an EV, or having any experience with an EV, it could have been beneficial to hear from more EV owners and evaluate their thought processes on why they decided to purchase an EV. This information could be shared to those who have doubts about purchasing an EV and may encourage them to

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switch to EVs. It would also be useful to see a study conducted comparing the views on EVs from individuals on low incomes and high incomes, as one of the major factors associated with EVs is the high initial purchase price.

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