

# Adoption of Electric Vehicles: Analysis of Consumer Perception in Ghana

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## Abstract

Several countries have introduced electric vehicles (EVs) to ensure sustainable transport. Germany, UK, Norway and France are some of the countries phasing out internal combustion engine vehicles, which contributes to significant proportion of CO<sub>2</sub> emissions. The government of Ghana has plans to develop policies to ensure consumers change from fossil-fuel-based vehicles to electric vehicles. The aim of this research was to find factors which will influence consumers' intentions to purchase electric vehicles. A questionnaire survey was conducted in the cities of Kumasi and Accra, Ghana. Convenient sampling method was used and the data analysed using IBM SPSS 23. The questions on which respondents were quizzed on included environmental concern, consumer knowledge/awareness, attitudes and government policy. From the analysis, the least consideration the respondents had when purchasing an EV was the environment. The most important factor considered by respondents (34.38%) in their purchase intention was the availability of infrastructure (e.g., charging stations and aftersales service centres). The purchase price and cost of operating of the vehicle was not given important consideration (1.17%). The most important feature/attribute of the EV that respondents considered was driving range (17.63%) and recharge time (16.13%). Significant proportion of respondents were worried about the reliability of electricity supply. Overall, 94% expected their vehicles to be charged under 30 minutes. An assessment of the daily travel patterns showed that range shouldn't be a problem as only 6.2% travel more than 50 km among the respondents. Emissions reduction was not one of the important attributes when it came to purchase intention of electric vehicles. Consumers were more concerned about the driving range and available infrastructure. Government must provide incentives to the private sector to enable them setup maintenance and service centres and also ensure stable and reliable power supply.

**Keywords:** Electric vehicles; purchase intentions; sustainable transport; environment; Ghana

## 1. Introduction

The expansion of economies has resulted in increased incomes and a resultant high purchasing power globally: a global increase in population mobility is a natural consequence. This has led to an increased demand for mobility – causing significant increase in CO<sub>2</sub> emissions, especially from the transport sector. The International Energy Agency, IEA, estimates that the transport sector contributed 25% (about 8 billion tons of CO<sub>2</sub>) of total global CO<sub>2</sub> emissions as at 2016; for Africa, the transport sector constituted 31% of total CO<sub>2</sub> emissions (IEA, 2018).

In Ghana, the Strategic National Energy Policy (SNEP) estimates that the transport sector consumes about 85% of diesel and 99.7% of gasoline in the economy (Energy Commission, 2006). This confirms the IEA's report which estimates that 6.7 million tons of CO<sub>2</sub> is from the road subsector, representing 52% of the Country's total CO<sub>2</sub> emissions (IEA, 2018). However, Ghana's transport system lacks comprehensive measures for minimizing environmental damage. Consequently, objective five of the Strategic National Energy Policy 2006 -2020 (2006) proposes to accelerate the development and utilisation of renewable energy and energy efficiency technologies.

The negative effects of these emissions are varied; for example, it has been estimated that air pollution kills over 20,000 people in Ghana annually (Benghan, 2019; Duncan, 2018). The annual deaths from air pollution in Accra alone is projected to rise to 4,600 people per annum by 2030 if action is not taken (Benghan, 2019). The World Health Organisation (WHO) cautions that deaths arising out of pollution of the air is expected to rise as urban population and vehicular numbers increase. The National Programme Officer for the WHO, Gordon Daaku, further states that vehicles are the main source of air pollution. He alluded to the fact that the city of Accra was inundated with cars and this was a major source of the pollution (Duncan, 2018). Mr Appah-Sarpong, the Deputy Chief Executive of the Environmental Protection Agency (EPA), says the economic cost of deaths from air pollution is higher than that caused by unsafe sanitation or underweight children. The projected annual economic cost of air pollution in Africa is \$250 billion dollars. To stop this, measures to reduce air pollution such as vehicle emissions strategies and standards, electronic mobility implementation strategies, the elimination of lead from gasoline are being put in place (Benghan, 2019).

These developments have compelled Supranational Organizations like the United Nations Framework Convention on Climate Change (UNFCCC) and various governments around the world to develop strategies for reducing Greenhouse gas (GHG) emissions to ensure sustainable development: one of such efforts is greening the transportation sector. To give effect to this plan to ensure sustainable transport, the use of electric vehicles has been muted and introduced in several countries including the Netherlands, Germany, the United States, Spain, Norway, China, etc. Electric vehicles - hybrid electric (HEV), plug-in hybrid electric (PHEV) or battery electric vehicle (BEV) technologies - provide the promise for a steady decline of energy consumption and GHG emission (Shen et al., 2012). The benefits of Electric Vehicles are further corroborated in a report commissioned by the European Climate Foundation (2018) which summarized that there was substantial reduction in greenhouse emissions (GHG) when there was a move from internal combustion engines (ICEVs) to electric vehicles in the timeframe and for countries involved in the scope of the study (Schuller and Stuart, 2018).

The Republic of Ghana, being a signatory to the Paris Agreement (2015) and the Sustainable Development Goals (SDGs), has thus committed to 'take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy' as captured in Goal 13 of the SDGs. The government has therefore announced plans to develop policies like removal of taxes on electric vehicles to ensure consumers change from fossil-fuel-based vehicles to electric vehicles and ensure Ghana's obligations under Agenda 2030 are achieved (Ministry of Finance, 2018).

The biggest hindrance to effectively rolling out such policies and achieving these targets is a proper estimation an understanding of consumer expectations and reservations. Specifically, there is no empirical research detailing the factors that will affect consumers' preference for

electric vehicles and the public policy prescription to be developed by the state as a consequence of such research.

## **2. Literature Review**

### **2.1 Challenges to Widespread Adoption of Electric Vehicles**

#### **Financial Benefits/Cost**

This refers to the savings to be made from the different costs associated with the purchase and use of electric vehicles as compared with internal combustion engines; these monetary costs include purchase price, fuel cost and operating and maintenance cost (Liao et al., 2017).

Purchase price is the upfront cost of the vehicle. Purchase price has been found to be a significant factor in consumers' behaviour, for example, price, brand, engine power, emission, fuel economy, car size-style are the preferred factors in Sweden (Chowdhury et al., 2016). Another study confirmed this when it was established that vehicle fuel cost and cost of an electric vehicle impacted on consumer choice (Hackbarth and Madlener, 2013). This implies that a higher purchase price puts a dampener on the interest of people to buy electric vehicles. It must however be stated that purchase price did not affect all consumers across different income levels or was not the most important factor, for example, Chowdhury et al (2016) found that existing owners of electric vehicles preferred engine power to other attributes, whereas those who didn't own one but were willing to rank price as the most important factor. In another study, some consumers were inclined to purchase very expensive products because of the perceived quality, whereas others went for ones that were cheaper because they were affordable (Narteh et al., 2012). Liao et al (2017) found that higher income earners are less sensitive to price; which confirms the postulation of Narteh et al (2012).

In a stated preference study, it was found that a higher utility was placed on reductions on fuel costs compared to reductions in vehicle registration tax and CO<sub>2</sub> emissions. Recommendations were therefore made to make fuel costs of these vehicles to be lower than conventional vehicles if the adoption of hybrid electric vehicles or alternative fuel vehicles is seen as publicly desirable (Caulfield et al., 2010). Ironically, people with higher incomes may not rate fuel cost as most important (Helveston et al., 2015). People with more purchasing power in China however found high fuel cost to be an influencing factor: meaning rich people in China found the daily cost savings or benefits from fuel strengthened their attraction toward electric vehicles (Helveston et al., 2015).

Maintenance cost also affect intentions. There are studies that have included regular maintenance costs or treated it as operations cost together with energy cost - electricity and fuel costs (Hess et al., 2011). Maintenance cost could include the cost of replacing oil filter, fuel filter and air filter (Wang and Liu, 2015). The reason for low maintenance cost for electric vehicles is because the replacement of the oil filter, fuel filter and air filter is not necessary (Wang and Liu, 2015). The low usage cost of electric vehicles therefore becomes a big incentive to acquire or adopt it; despite the high cost price (purchase price), the low usage cost has become an incentive for people to adopt electric vehicles (Caperello and Kurani, 2012). In a survey of a thousand residents, respondents rated low usage cost ahead of environmental benefits and

respondents whose attention was focused on low usage cost were likely to buy electric vehicles (Krupa et al., 2014).

### **Available Infrastructure**

This refers to publicly available public charging stations (technology facilitating conditions) that enable consumers to recharge their electric vehicles (Sang and Bekhet, 2015). Additionally, charging of electric vehicles must be easy, readily available and there must be enough capacity so these vehicles can be charged (Lee and Lovellette, 2011). There hasn't been a universal agreement on the definition of available charging infrastructure; some define it based on how the charging stations are spread per area as compared to gas stations. It can be defined as the presence of charging stations in different areas, i.e., malls, work, homes (Rasouli and Timmermans, 2016).

In considering alternative fuels, including vehicles powered by electricity, the issue of available infrastructure plays a great role in buying electric vehicles (Liao et al., 2017). Research has proved that a lack of charging infrastructure is a cause of low uptake of electric vehicles (Martin et al., 2009). The market penetration for electric vehicles will improve with fast-charging infrastructure – which ultimately also support long range drive (Schroeder and Traber, 2012). The low penetration is mainly because of “drivers’ range anxiety”; electric vehicles with short driving range impede long-distance travel (Wang and Liu, 2015). To remove this anxiety and increase intentions and behaviour substantially, it will be very important to ensure that the charging infrastructure is sufficiently available to eliminate the users’ “range anxiety.” A respondent in a related research conducted by Caulfield et al (2010) wrote: ‘The relative lack of availability of biofuel has been a factor since I bought the car. Good intentions only go so far if you can’t get the fuel’ (p22).

Liao et al (2017) in his review found that the availability of charging infrastructure in a lot of studies had a significantly positive effect. This effect could be non-linear with a decreasing marginal utility (Achtnicht, 2012). It can be said, based on research, that charging stations at the place of work is highly favoured by long distance commuters (Jensen et al., 2013). Consumers also prefer that charging stations are readily available at shorter distances (Potoglou and Kanaroglou, 2007). Hackbarth and Madlener (2013) corroborate this in their study which established that the density of the filling station network has a positive effect on people’s decisions; a preponderance of refuelling infrastructure reduces the chance of being stranded because of low fuel.

Since electric vehicles are fuelled partially or fully by electricity, there is need to have power which is reliable. There are worries that the distribution and transmission infrastructure may be inadequate or not available where there is need for it (Scarcella et al., 2012). The provision of electricity may be less difficult because every household has access to power; in contrast, gasoline fuel is not so. That notwithstanding, Scarcella et al (2012) argue that it is necessary to examine future demand since consumption of electricity will go up with increased uptake of electric vehicles. This will help governments determine whether to intervene or let the private sector take full charge. Appropriate charging infrastructure may be needed at homes since most electric vehicle users will mostly charge their vehicles at home (Scarcella et al., 2012).

The perceived quality of service complemented by maintenance services for electric vehicles is important as well. Consumers’ adoption of electric vehicles will depend on these factors as

well (Ng et al., 2018). Nartey et al (2012) confirmed this in his research of automobile buyers that the customers expect that there will be sales points or offices and centres where customers can go to repair or service their cars.

### **Car Attributes**

Consumers purchase cars based on several features on a car. Nartey et al (2012) found that car features play an important role in the selection of any automobile brand in Ghana. The core attributes of the car played a role in consumer choice of the car brand - the design of the car, car colour and glaze, performance, and size all influenced the Ghanaian consumer decision (Nartey et al., 2012). Consumers value the performance of the car, car aesthetics, reliability, and many other attributes (Lee and Lovellette, 2011).

It has been established that driving range is a major concern for potential electric vehicle buyers (Hackbarth and Madlener, 2013; Lee and Lovellette, 2011; Simsekoglu and Nayum, 2019). Driving range is the distance (miles or kilometres) an electric vehicle can be driven before it will need to be recharged (Lee and Lovellette, 2011). Normally, consumers would want to purchase a car which has the same range or a superior range to their previous buy. However, electric vehicles are limited by their short driving range as compared to internal combustion engines (Lee and Lovellette, 2011). The reason being that electric vehicles run on batteries that can be recharged and can, therefore, travel up to say 100 miles before being recharged again (Egbue and Long, 2012; Haaren, 2011; Hardman et al., 2017; Pilkington and Dyerson, 2002). A trip of more than 200 miles (322 km) may therefore make the electric vehicles less suited for such trips (Krumm, 2012; Wahab and Jiang, 2019). A driving range of more than 200 miles may be very advantageous for electric vehicles; for example, Hackbarth and Madlener (2013) established that the improvement of a battery electric vehicle's driving range to 750 km in a simulation led to a 143% increase in the demand for same. The available range currently is 160 km, on average. This is because the current technology can support only 160 km of travel before a recharge (Giffi et al., 2011).

Charging time is very important in the adoption of electric vehicles (Wahab and Jiang, 2019). Several studies have confirmed that the charging time of electric vehicles is a determinant in adoptions (Egbue and Long, 2012; Hackbarth and Madlener, 2013; Lee and Lovellette, 2011). A very long time in recharging electric vehicles will not endure electric vehicles to potential buyers. Hackbarth and Madlener (2013) found that the utility of an electric vehicle greatly reduces with prolonged charging. This is mainly because internal combustion engines generally refuel within 4 minutes. However, electric vehicles may take about 30 minutes to charge (where fast charging is available); charging may take 10 hours or more where fast charging is not available (Tom Saxton, 2011). In contrast, van Rijnsoever et al (2013) argued that time taken to recharge was not a highly rated attribute, because consumers felt electric vehicles can be charged ahead of time, even though they also established that recharging electric vehicles for 8 hours greatly lowered consumer satisfaction. The time it takes to charge may not be important if it does not take more than 10 minutes. To increase utility, refuel should be reduced to 30 minutes (Hackbarth and Madlener, 2013; van Rijnsoever et al., 2013). Hackbarth and Madlener (2013) found out in a simulation in their study that a decrease in recharge time to 5 minutes increased the market share.

Car Performance, normally comprises engine power, acceleration time or maximum speed: consumers would normally prefer better performance (Liao et al., 2017). However, it was

found that acceleration time was insignificant due to the diversity in preferences in a study (Mabit and Fosgerau, 2011). Males, for instance, were found to prefer faster acceleration while females didn't (Mabit and Fosgerau, 2011; Potoglou and Kanaroglou, 2007). Electric vehicles are superior to traditional fuel cars because they have superior features (Wang and Liu, 2015). Some hybrid vehicle drivers rate performance attributes such as comfort of driving, quietness and ease of driving as significant factors that affect their adoption (Ozaki and Sevastyanova, 2011). Chowdhury et al (2016) found that Swedish drivers rated engine power as the most important attribute. Premium is placed on the performance of a car because consumers normally would buy cars which have performance than their previous cars (Lee and Lovellette, 2011).

In a review of a survey by Deloitte Consulting in the United States of America, it was found that consumers considered the reliability of electric vehicles and short battery life as important factors (Wang and Liu, 2015). Furthermore, Jensen et al (2013) found, after three-month trial of electric vehicles by selected consumers, an increase in the influence of battery life on adoptions, though they found it not to be that significant. Due to the uncertainties surrounding the issues of battery life of electric vehicles, consumers may not be amenable – it is therefore a relevant issue to be looked at (Jensen et al., 2013; Liao et al., 2017).

The availability of different models can increase the likelihood of choosing an electric vehicle because it proves the maturity of electric vehicles in the car market and thus influences people's perception of uncertainty (Hoen and Koetse, 2014). The low sales of electric vehicles could partly be because of this as consumers may not like the brands available or would prefer to have a lot of options to pick from (Liao et al., 2017).

### **Environmental Concerns/Awareness of Consumers**

Environmental concern is a very important factor in acceptance and uptake of electric vehicles; because using an electric vehicle is seen as a necessary step which will help protect the environment (Rezvani et al., 2015). Environmental concern shows how worried people are about the environment and how eager they are in supporting efforts to solve these problems (Sang and Bekhet, 2015).

As the degradation of the environment in recent years has heightened consumer concerns, calls have been made for an examination of how consumer awareness and environmental concerns are related (Ramayah et al., 2012; Roberts, 1996). Studies have established relationships between environmental concerns and consumer behaviour towards the environment (Wang et al., 2016). It has been proved that a substantial relationship exists between environmental concerns and attitudes towards Alternative-Fuel Vehicles – the more concerned a consumer was about the environment, the positive his/her attitude towards alternative-fuel vehicles (Turcksin et al., 2013). This is corroborated in a study which established that people who were very concerned about the environment were likely to purchase electric vehicles (Krupa et al., 2014). Another factor militating against a direct relationship between environmental concern and consumer behaviour is limited knowledge levels. Little knowledge of environmental issues seem to hinder the building up of awareness of Alternate-Fuel Vehicles, which is the key to their adoption (Ogarra et al., 2005; Thesen and Langhelle, 2008; Turcksin et al., 2013). The study by Afroz et al (2015) in Malaysia provided further prove that lack of knowledge about environmental issues had a negative effective on consumer behaviour. In that research, it was

found that Malaysian consumers were largely unaware of greenhouse effects or attached little importance to it, and this affected the intentions to purchase electric vehicles.

In a study, existing owners and potential owners rated emissions ahead of fuel efficiency partly because the Swedes viewed the outcome of greenhouse emissions and climate change to be of a higher cost, and so they were ready to pay to mitigate the consequences of emissions and climate change (Chowdhury et al., 2016).

### **Government Policy/Intervention (GP)**

In the nascent stages of electric vehicle growth, government is the driving force (Wang and Liu, 2015). To encourage electric vehicle uptake, policies must be developed by governments to achieve this: the policies could be monetary incentives and non-monetary incentives (Wang and Liu, 2015). The incentives could include subsidies for those who buy or install home charging equipment, purchase incentives (reduction of taxes in the price build-up of electric vehicles), providing tax holidays for those who set up charging infrastructure and reducing electricity cost (reduction of taxes on electricity, reclassifying electric vehicle consumers into a different tariff bands). It could also be in the form of taxes placed on high emissions-generating vehicles. A typical example of rebates is the 5.7% rebates given on purchase price in Japan, \$7500.00 given per vehicle in the US, and \$2500.00 given in the state of California (Tanaka et al., 2014). The non-monetary incentives could include road tolls exemptions, strictly restricting certain urban areas to electric cars only and free public charging; for example, some cities in Europe have placed travel restrictions, through schemes like cordon pricing (Lee and Lovellette, 2011).

It has been argued that tax subsidies go a long way in encouraging consumer purchase more than any other supporting incentives (Gallagher and Muehlegger, 2008). Furthermore, it is established that environmental regulations, oil price policy, purchase subsidies and the charging infrastructure construction improves the market penetration of cleaner vehicles (Lane and Potter, 2007). In a model applied in a study, it was found that purchase tax exemptions led to positive outcomes, but free parking and use of designated lanes did not have any positive effect (Potoglou and Kanaroglou, 2007).

## **3. Approach and Methodology**

### **3.1 The Study Area**

The research focused on sampling responses from drivers in Kumasi and Accra. Kumasi is the regional capital of Ashanti Region. It is 270 km from the national capital, Accra. The population of Kumasi is 1,730,249. This is 36.2% of the total population of Ashanti Region (Ghana Statistical Service, 2014).

Accra is the regional capital of the Greater Accra Region and also the national capital of the Republic of Ghana. It has a total population of 1,665,086 which is 42% of the total population of Greater Accra Region. Accra and Kumasi were selected because they have the most concentrations of vehicles (Business & Financial Times, 2013; Essel, 2016).

### 3.2 Sample Size

The sample size was calculated using the formula below (Macorr Research Solutions, 2013):

MACORR RESEARCH FORMULA											
ss	population sample size										
Z	z-value in Z table (depending on confidence interval, CI)										
p	Percentage picking a choice expressed as a decimal										
q	1 - p										
C	Confidence interval expressed as a percentage (100-CI)										
CI	Confidence interval										
	Z	Z <sup>2</sup>	p	1 - p	CI	C	C <sup>2</sup>	Z <sup>2</sup> *p*(1-p)	Z <sup>2</sup> *p*(1-p)/C <sup>2</sup>	ss	Remarks
	1.96	3.842	0.5	0.5	95	0.05	0.003	0.9604	384.16	385	The proportion of vehicles per population is 50%, therefore p is 0.5; confidence interval is (CI) 95%; Z is 1.96; C is 5% (since the level of confidence is 95%: 100% - 95% = 5%)

**Figure 1 Sample Size Calculation (Macorr Research Solutions, 2013)**

The sample was increased to 400 to account for 5% response error (Afroz et al., 2015).

### 3.3 Sampling

The survey was conducted in May, 2019 among drivers who were 18 years and above; respondents who had not driven before were excluded. The questionnaire survey was conducted by face-to-face interviews at workplaces, mechanic workshops and commercial vehicle stations in Kumasi and Accra. The questionnaires were also administered at the offices of the Driver and Vehicle Licensing Authority (DVLA) to the staff of DVLA and drivers who had gone to the DVLA for some service. Convenient sampling method was used because of the large nature of the population under consideration and the respondents were readily available. Also, it was used because it was easy and fast to do (Afroz et al., 2015).

The number of questionnaires distributed for the main project were 483 in number, however, 404 questionnaires were found to be usable.

## 4. Results

### 4.1 Demographic Profile

The respondents were predominantly male – 80.7% male and 19.3% female- as shown in table 4-1. The bulk of the respondents were youthful – 70.3% were between the ages of 20 to 40 years. Those below 20 years constituted 2.7%: combined with those considered to be youthful, the percentage of young respondents, as defined in the 2010 population and housing census, are



73%. This nearly mirrors the national situation where those below 35 years are 75.3% (Ghana Statistical Service, 2013). Almost half (49.5%) of the respondents had education up to the Senior High School level. The income level, as borne by the data, showed that almost two-thirds of the respondents earned between Gh¢ 500.00 and Gh¢ 2000.00 per month, as shown in Table 1.

**Table 1 Demographic Profile of Respondents**

<b>Demographics</b>	<b>Frequency</b>	<b>Percentage (%)</b>
<b>Gender</b>		
Female	78	19.3
Male	326	80.7
<b>Age (Years)</b>		
below 20	11	2.7
20-30	68	16.8
30-40	216	53.5
40-50	95	23.5
50-60	10	2.5
>60	4	1.0
<b>Educational Level</b>		
SHS or lower	200	49.5
diploma	23	5.7
graduate	107	26.5
postgraduate	72	17.8
other	2	.5
<b>Income Level (Gh¢)</b>		
below 500.00	31	7.7
500.00 -1,000.00	117	29.0
1,000.00 -2,000.00	144	35.6
2,000.00 -3,000.00	40	9.9
3,000.00 - 4,000.00	23	5.7
4,000.00 - 5,000.00	16	4.0
above 5,000.00	33	8.2
<b>Car Ownership</b>		
yes	202	50.0
no	202	50.0

#### **4.2 Ranking of Car Attributes**

The most important feature in a car that respondents preferred was driving range; 17.63% chose driving range as the most important feature they will look at in an electric vehicle. This was followed by 16.13% choosing recharge time as the next most important feature, as shown in Table 2.

**Table 2 Ranking of Most Important Vehicle Attribute**

	<b>Weighted Total</b>	<b>Percentage of Total (%)</b>
Performance	1773	15.83
Comfortable ride	1353	12.08
Different Models	1128	10.07
Reliability	1740	15.54
Recharge Time	1807	16.13
Reducing Emissions	1424	12.71
Driving Range	1975	17.63
<b>Total</b>	<b>11200</b>	<b>100.00</b>

**4.3 Ranking of Purchase Factors**

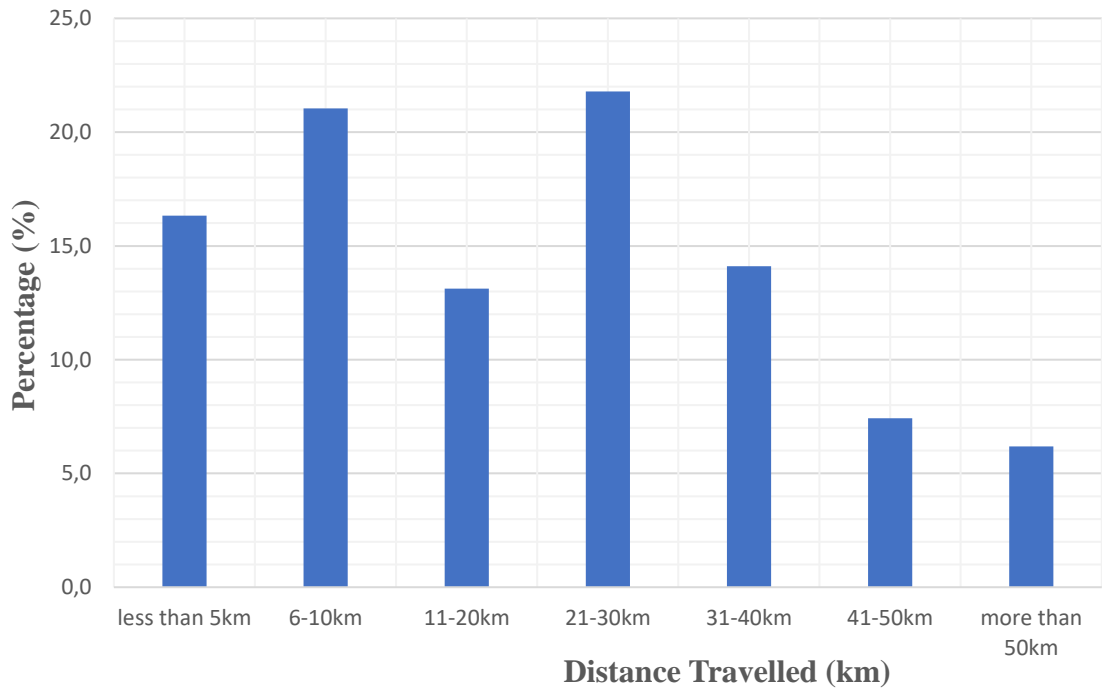
The most important factor considered by respondents was the availability of infrastructure for electric vehicles; 34.38% of respondents ranked it as the most important. This was followed by 33.07% of respondents who considered Government support/policy as the most important factor; 30.59% chose car attributes/features as one which will receive the first consideration.

**Table 3 Ranking of Most Important Purchase Factors**

	<b>Weighted total</b>	<b>Percentage of Total (%)</b>
Env't Contr.	773	0.78
Purchase Price & operating cost	1165	1.17
Infrastructure	34103	34.38
Government Support	32803	33.07
Car Attributes	30340	30.59
<b>Total</b>	<b>99184</b>	<b>100.00</b>

**4.4 Distance Travelled Daily**

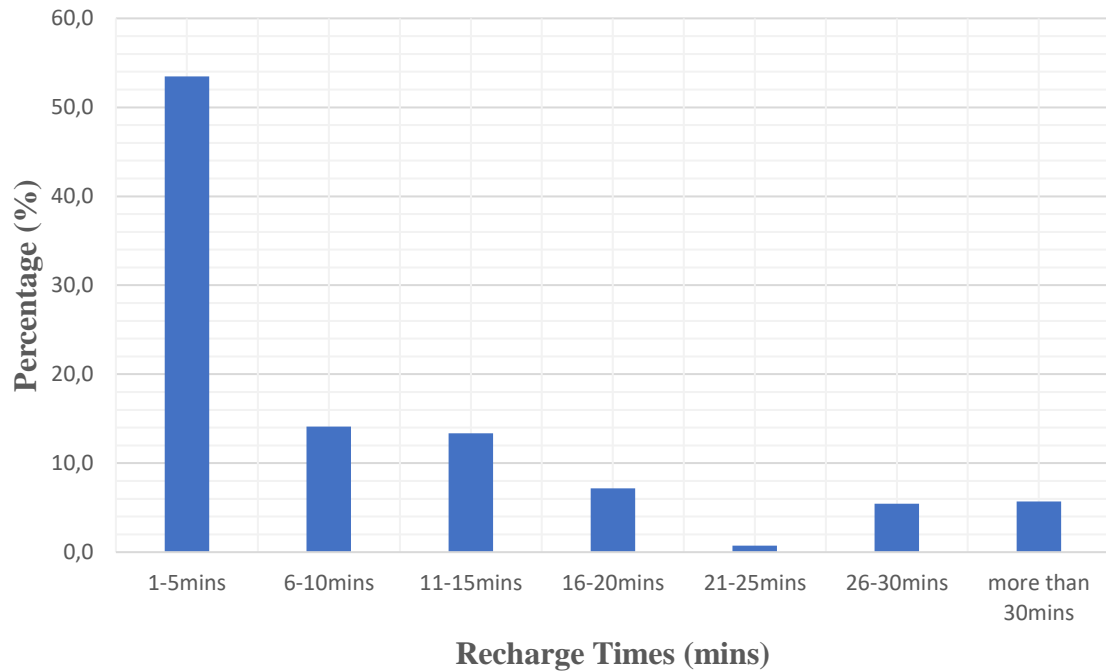
An assessment of the daily travel patterns showed that 16.3% of respondents travelled less than 5 km a day; 21.0% travelled between 6 and 10 km, 13.1% between 11 and 20 km, 21.8% between 21 and 30 km; the distance travelled daily by respondents is shown in Figure 2.



**Figure 2 Distance Travelled Daily**

#### **4.5 Charging Times at Public Recharge Stations**

The results show that two-thirds – 67.6% - expect the charging times to be between a minute and ten minutes at public recharge stations; 53.5% expect charging to be within 1 to 5 minutes and 14.1% expect their electric vehicles to be charged within 6 to 10 minutes at public recharge stations; 13.4% expect their vehicles to be charged within 11 to 15 minutes. This is represented in Figure 3.



**Figure 3 Recharge Times at Public Recharge Stations**

## 5. Discussions

The three most important feature in a car that respondents preferred were driving range, recharge time and vehicle performance. The results confirm studies that suggest that the attributes of an electric vehicles are very important factors in the purchase of electric vehicles (Hackbarth and Madlener, 2013; Lee and Lovellette, 2011). Environmental contribution was the least considered purchase factor. This is in sync with other studies that showed that environmental concern is not the main driver or one of the main drivers of consumers when they decide to purchase an electric vehicle (Afroz et al., 2015; Wang et al., 2016). The most important factor considered by respondents was the availability of infrastructure for electric. This confirms other studies which reported that availability of electric vehicle infrastructure was an important factor in increasing the uptake of electric vehicles (Caulfield et al., 2010; Liao et al., 2017). Surprisingly, the purchase price and cost of operating an electric vehicle was considered most important by only 1.17% of respondents. This is supported by another study which found that upfront cost and the cost associated with the use of an electric vehicle was one of the least important considerations (Egbue and Long, 2012).

The results show that range shouldn't be a problem as only 6.2% travel more than 50 km among the respondents; comparatively, the National Highway Administration in the U.S.A has established from their Household Travel Survey that people travel under 20 miles each day, generally (Hu and Reuscher, 2004; Lee and Lovellette, 2011). This is further reinforced by a related outcome where 80% of those surveyed drove for less than 80 km daily (Giffi et al., 2011). The range issue cannot be taken for granted, nonetheless, because range issues still plague the successful roll out of electric vehicles. For drivers who travel for less than 50 km a day, they will not need to worry about range because the technology available currently allows a lot of vehicles to run on stored electricity for up to 160 km (Giffi et al., 2011).

It is not surprising that majority of the respondents expect the vehicles to be charged in 5 minutes as it is estimated that conventional vehicles usually refill within 4 minutes (Hackbarth and Madlener, 2013; Tom Saxton, 2011). It must be noted that most consumers expect their vehicles to be charged quickly (Giffi et al., 2011; Lee and Lovellette, 2011). In Japan, the consumers expect their vehicles to be charged in no more than 30 minutes (Giffi et al., 2011); the results recorded in this research is therefore not far from the expectations of many consumers across the globe. However, the reality is that most technologies available currently is unable to meet this expectation. There are 3 levels of charging available depending on the level of power they can provide the batteries of electric vehicles (Giffi et al., 2011; Lee and Lovellette, 2011). Level 1 provides charging from 10 to 20 hours, while level 2 can provide full charge between 3 to 8 hours. The vehicles can be fully charged in 30 minutes at level 3; however, there are issues with safety due to the high voltage required with level 3 charging and the pressure it brings on grid capacity as well (Giffi et al., 2011). The cost of setting up a level 3 charging is high and it also degrades the battery at a faster rate due to high wear and tear (Giffi et al., 2011). Also, the setting up of fast charging stations may not be viable if the demand or penetration rate is low (Gnann et al., 2018; Schroeder and Traber, 2012). As the penetration rates of electric vehicles are very well low or not existent in Ghana, the prices to be paid by consumers if fast charging stations (level 3 charging) are provided will be prohibitive. Most studies recommend level 2 charging as it provides the best option under the current circumstances: in terms of cost, safety, battery life, ease of setting it up and stress on the national grid (Giffi et al., 2011; Lee and Lovellette, 2011).

## **6. Conclusions, Recommendations and Further Research**

The desire to reduce emission levels have led to various solutions, including reducing same in the transport sector. Proposals for the electrification of transport has received widespread attention and implementation in several countries including Germany, the United Kingdom, Norway, Sweden, etc. The idea of introducing electric vehicles in Ghana to reduce emissions and to meet the country's international obligations is gaining currency. This research sought to establish factors to be considered by the government and other stakeholders as plans are rolled out to achieve such noble goals.

The three most important electric vehicle attributes were driving range, recharge time and vehicle performance. The ability of the electric vehicle to help reduce emissions was not ranked as a very important car attribute. Also, the contribution of the electric vehicle to help reduce emissions (EV's environmental contribution) was not ranked as a very important purchase factor; rather, available infrastructure, government support and vehicle attributes were ranked as the most important factors consumer would consider when purchasing an electric vehicle. The results show that the concern of consumers about the environment may not be compelling enough for them to purchase electric vehicles; due to the lack of information and awareness about the debilitating effect of fossil fuels and the advantages of electric vehicles.

Majority of respondents expect the electric vehicle to be recharged as fast as conventional vehicles. This may be difficult to achieve due to infrastructure constraint. Lastly, most respondents travelled for less than 50 km daily. This should mean that consumer anxiety over range should not be a problem, however, it can not be discounted as the results show that the most important car attribute is driving range.

It is important that all stakeholders (government, transport officials, manufacturers, marketers) consider raising awareness among consumers about the negative effects of conventional vehicles, while educating them about the benefits of electric vehicles. This will help make consumers conscious of the environment and lead to increased interest in environmentally friendly vehicles. It will be necessary for transport officials, producers of electric vehicles and marketers to increase consumers' familiarity with electric vehicles through test drives to build up consumer confidence; further to this, the government should consider rolling out electric vehicles on a pilot bases – starting with Hybrid Electric Vehicles. This will help build the right consumer experience and obtain important feedback - to help satisfy the needs of Ghanaian consumers. Government and transport officials should concentrate on proving the infrastructure that can support the roll out of electric vehicles. The infrastructure must include reliable and stable electricity and adequate public recharge stations.

This study covered only two cities in Ghana - Kumasi and Accra – even though the bulk of vehicles are concentrated between these two cities, there might be differences of opinions in other cities and other major towns, it may be necessary to include other cities in subsequent research; it may also be necessary to capture more women in subsequent surveys as the percentage of women was rather low (19.3%). The determination of the distances travelled by respondents was based on self-reports by respondents; in future research, consideration could be given to measuring actual distances travelled by respondents daily to obtain very precise estimates.

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