CAS829: Evaluation Techniques for Working Professionals

Developing a Research Plan

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Are Americans Consumers Willing to Buy-In to Electric Vehicles?

As the debate surrounding fossil fuels, climate change, and the impact people have on their environment continues, we ask, are American consumers ready to embrace electric vehicles? It stands to reason the country credited with putting the world on wheels would be the driving force behind the innovation and vehicle electrification, but is that the case, and if it isn't, why?

Literature Review

Several barriers could be responsible for the perceived disinterest of the American consumer, including an aging population wary of change, an influential oil and gas lobby, the higher initial purchase price of electric vehicles, a general lack of awareness, and a limited selection of vehicles. However, several US automakers have recently announced plans to increase electric vehicle production. In January 2020, General Motors committed to releasing 30 electric vehicles by 2024 to phase out the production of petroleum-powered vehicles and sell only vehicles with zero-emission tailpipes by 2035 (gm.com). Other limitations to widespread electric vehicle adoption include aging infrastructure and the national power grid unable to keep pace with demand.

Understanding the U. S's dependency on petroleum

The United States is the number one consumer of petroleum globally; China is a distant second. In 2020, US petroleum consumption averaged about 18.12 million barrels per day, and that figure is expected to continue growing through at least 2050. Gasoline is the country's most consumed petroleum product, with transportation needs accounting for 66% of petroleum consumption (US Energy Information Administration). The bottom line? Oil and gas is big business for the United States.

Elsewhere, the international community is taking bold measures and calling for climate change to be addressed as a serious global threat. The European Commission introduced a package of policy initiatives aimed at making the European Union (EU) climate net neutral by 2050. Part of its strategy also relies on allies like the United States to take a similarly aggressive stand and invest in climate friendly technology. As Europe replaces old technology with renewables, the demand for crude oil will decrease

and significantly impact the global oil market (Leonard, 2021). This could cause dramatic fluctuations on the global economy and countries unprepared to keep pace with the changes should be prepared for the future risk. This includes major trading partners of the EU, like the United States. The EU's Green Deal will require stricter emission standards for vehicles and a carbon tariff the US should expect major economic impacts to the exportation of fossil fuels and manufactured products (Leonard, 21).

U.S. manufacturers should already be thinking strategically about the increasing demand for electrification. China already accounts for 60 percent of electric vehicle sales globally (Baker III, 2020). When you consider those numbers and the goals set forth by the EU, the United States can't afford to lag behind this movement.

The Impacts of Climate Change

The Yale Program on Climate Change Communication has been studying public opinion related to climate change over the last decade and finds the majority of Americans believe global warming is happening as a direct result of human activity and are somewhat concerned about the trend (Ballew, 2019). More importantly, the study finds more than 80% of adults support tax rebates for people who purchase energy-efficient vehicles or solar panels (YPCCC, 2020). But the magnitude, type, and immediacy of incentives are strong drivers for adoption (Gallagher 2011).

Slow to Adopt

Currently, there appears to be little to no incentive for US consumers to change their fuel consumption or behaviors, and significant improvements to the infrastructure—particularly in rural areas—must be addressed. (Lowell, 2020). Additionally, the 2013 study Perception and Reality: Public Knowledge of Plug-in Electric Vehicles in 21 US Cities found "most consumers are either uninformed or misinformed about plug-in electric vehicles (PEVs). Over 60% of the time, respondents answered basic factual questions about PEVs incorrectly. Of those incorrect answers, 75% underestimated the value or advantage of PEVs, and only a negligible number of respondents were aware of the state and local incentives that are available in their own locales" (Krause, 2013).

A lack of resources, aging infrastructure, and the isolated nature of rural communities presents a unique challenge for those wishing to promote EVs. But those areas stand to benefit the most from electrification. Electric vehicles, more efficient travel routes and connected streets, and a host of other invests could pay off in the long run, potentially saving rural residents (who historically earn lower wages than people living in more urban or metropolitan areas) thousands of dollars annually (Lowell, 2020). A growing number of cities have committed to electrifying public transportation, but the invest also needs to be made in the freight—or long-haul trucking—industry, which has an outsized impact on rural communities (Heffling, 2018). Making the change feasible will require significant investment at the local, state and federal level. Rebates, grants, and incentives are necessary to encourage local businesses to invest in upgrades like charging stations. Educational programs need to be developed so people understand how to service EVs. Even private residences will require electrical upgrades to accommodate home charging options (Lowell, 2020).

A 2018 study of the United States' neighbors to the north reveals Canadians seem overwhelmingly (more than 60 percent) open to electrified vehicles and as a country, Canada's electricity generation profile is considered one of the cleanest in the world. Geography, education, and income were integral factors in the participants' favorability ratings of electric vehicles. Interestingly the Canadian study found while the majority of participants in Canada's metro areas viewed electric or plug-in vehicles in a positive light, "the Windsor, Ontario metro, which is directly adjacent to Detroit and is tightly integrated with Detroit in automotive manufacturing supply chains, and internal combustion engines" (Ferguson, 2018). It also suggested a level of familiarity with traditional vehicle mechanics and a resistance to change or disruption of the status quo led people to prefer internal combustion engines over battery powered vehicles.

It stands to reason that while most Americans believe climate change is happening and acknowledge the role humans have played in climate change, it is their level of formal education, geography, civic engagement, and general knowledge of EV technology that has a direct relationship to their willingness to purchase an EV.

Hypotheses

H1: There will be a significant negative correlation between younger adults and a willingness to purchase an EV Often considered to be digital natives, people born after 1995 (Prensky, 2001) are more comfortable with technology and therefore more likely to adopt electric vehicles.

H2: Consumers who are willing to pay more than $50,000 on a vehicle will also be more likely to purchase an electric vehicle. The current upfront costs associated with buying an electric vehicle (sticker price, home charging station) mean people with higher incomes have the means to purchase an EV A higher WTP also indicates a higher income bracket, which is often associated with a more educated person. As noted early people who have continued their education past the basic 12 year program are more likely to be aware of climate change and the impact their actions have on the issue (Dumortier, 2015).

H3: The higher level of formal education a person attains results in a positive correlation to electric vehicle adoption. Research suggests the more education a consumer has achieved, the more likely they are to be aware of climate change and the direct impact they have on the environment and climate. They also believe it is their responsibility to take the necessary measures to reduce their carbon footprint.

H4: Men are more likely than women to buy an electric vehicle. Empirical evidence suggests men are more likely to adopt new technology than women, particularly men under the age of 50 (Kennedy & Funk, 2016)

H5: People who view technology favorably are more likely to purchase an EV For more than a century, internal combustion engines have been the standard. Consumers understand or at least feel comfortable with how they work. The unknown tends to make people uncomfortable. But early adopters are ahead of the curve and embrace the technology whatever it may be. Consumers who have smartphones and cloud-based A.I. in their homes are more likely to embrace EV

H6: Urban consumers will be more likely to purchase an EV Rural communities lack the infrastructure to support widespread EV adoption. But larger, urban areas have the electrical grid able to support the increased demand, better public transportation options, and have already installed public charging stations (Lowell, 2020).

Survey Draft

Welcome and thank you for taking the time to participate in this survey. It should take approximately 10-15 minutes to complete. Your answers will help us understand the relationship between technology and where you live, and your identity is entirely anonymous. Your honesty could determine future policy and influence free market developments. This is your opportunity to be heard and ensures you have choices and products that fit your needs and you want to buy!

Demographics

1) Do currently you own a vehicle?

    1) Yes

    2) No

        (*this is a screening question, anyone answering "No" should be taken to the end of the survey and shown the following message. Thank you for you willingness to participate in this survey. At this time we are looking for people with vehicles to assess their thoughts on vehicle ownership.)*

2) Please indicate your age

    1) 18-24

    2) 25-29

    3) 30-34

    4) 35-39

    5) 40-44

    6) 45-49

    7) 50-54

    8) 55-60

       9) 60-64

      10) 65+

3) Choose your gender

    1) Female

    2) Male

    3) Transgender

    4) Prefer not to say

4) Marital status

    1) Divorced

    2) Married or domestic partnership

    3) Separated

    4) Single, never married

    5) Widowed

5) Race

    1) American Indian or Alaska Native

    2) Asian

    3) Black or African American

    4) Native Hawaiian or Other Pacific Islander

    5) Two or more races

    6) White

    7) Prefer not to say

6) Education

    1) Some high school, no diploma

    2) High school graduate, diploma or the equivalent (for example: GED)

    3) Some college credit, no degree

    4) Trade/technical/vocational training

5) Associate degree

6) Bachelor's degree

7) Master's degree

8) Professional degree

9) Doctorate degree

7) Annual Income

   1) Less than $35,000

   2) 35,001-45,000

   3) 45,001-55,000

   4) 55,001-65,000

   5) 65,001-75,000

   6) 75,001-85,000

   7) 85,001-95,000

   8) 95,001-110,000

   9) 110,001-125,000

   10) 125,001-150,000

   11) 150,001-175,000

   12) 175,001-200,000

   13) 200,000+

8) Think about where you live. Would you describe the area as rural, suburban or urban/metropolitan?

   1) Rural

   2) Suburban

   3) Urban/Metropolitan

9) Do you live in a community with a population of

   1) Less than 10,000

   2) 10,001-25,000

3) 25,001-100,000

4) 100,001-500,000

5) 500,000-1,000,000

6) More than 1,000,000

10) Do you have children living at home with you?

    1) No (skip to next section)

    2) Yes (if yes, continue to question 11)

11) How many children do you have?

    1) 1

    2) 2

    3) 3

    4) 4

    5) 5+

Current vehicle ownership

1) 1. What type of vehicle do you currently drive?

    1) Economy or compact

    2) Sedan

    3) Minivan/Crossover

    4) Full-size SUV

    5) Light duty truck

    6) Full sized truck

2) On average, how many miles do you drive per year?

    1) Less than 15,000

    2) 15,001-25,000

    3) 25,001-30,000

    4) 30,001-50,000

5) 50,001-75,000

6) 75,001-100,000

7) More than 100,000

3) Thinking about your daily driving habits, miles do you drive each day?

1) Less than 10 miles

2) 10-25 miles

3) 26-35 miles

4) 36-50 miles

5) 51-75 miles

6) More than 75 miles

4) How long have you owned your current vehicle?

1) Less than 1 year

2) 1-3 years

3) 3-5 years

4) 6-10 years

5) More than 10 years

5) Did you finance your current vehicle?

1) No

2) Yes

6) Do you plan to buy a new vehicle in the next five years?

1) No

2) Yes

Vehicle preferences

1) When purchasing a new vehicle, what types of features or benefits do you consider before buying

(check all that apply)?

1) Fuel economy (miles per gallon)

    2) Passenger space

    3) Purchase price

    4) Safety rating

    5) Country of origin

    6) Brand

    7) Towing capacity

    8) Cost of ownership

    9) Drive train

    10) Acceleration rate (how fast the vehicle reaches 60mph from zero)

    11) Friend's recommendations

    12) Third-party recommendations or reviews

    13) Longevity

2) Please rank those features or benefits from most to least important (sliding scale with 1 being the most important).

    1) Fuel economy (miles per gallon)

    2) Passenger space

    3) Purchase price

    4) Safety rating

    5) Country of origin

    6) Brand

    7) Towing capacity

    8) Cost of ownership

    9) Drive train

    10) Acceleration rate (how fast the vehicle reaches 60mph from zero)

    11) Friend's recommendations

    12) Third-party recommendations or reviews

13) Longevity

3) Thinking about how much you paid for your current vehicle, how much are you willing to pay for your next vehicle purchase (in US dollars)?

  1) Less than 10,000

  2) 10,001-20,000

  3) 20,001-25,000

  4) 25,001-35,000

  5) 35,001-45,000

  6) 45,001-55,000

  7) 55,001-65,000

  8) 65,001-75,000

  9) More than 75,000

4) Where do you typically buy your vehicles?

  1) Dealership

  2) Friends or family

  3) Classified ad

  4) Online retailer

5) How is your current vehicle powered?

  1) Gasoline (Internal Combustion)

  2) Plug-in Hybrid Electric Vehicle

  3) All Electric Vehicle

6) Thinking about your next vehicle purchase how likely are to purchase a...

  (Please rate on a scale of extremely likely, likely, no opinion, not likely, definitely not likely)

  1) Gasoline (internal combustion)

  2) Plug-in Hybrid Electric Vehicle

  3) All Electric Vehicle (battery powered)

The next answers should be answered and a scale of strongly agree, agree, no opinion, disagree, strongly disagree.

7) I enjoy shopping for a vehicle

8) I trust vehicle salesmen/women

9) I want to test drive a vehicle before buying it

10) Buying a vehicle from a dealership allows me to learn all the benefits and features of the vehicle.

Technology

1) I own a smartphone.

    1) Yes

    2) No (*participants answering no should be taken to question 4*)

2) My smartphone operating system is an

    1) Apple

    2) Android

3) Thinking about the type of smartphone you use which answer best represents your reason for choosing your device.

    1) It is the most technologically advanced device on the market

    2) My friends or family own the same device

    3) It's looks appealed to me

    4) It was the cheapest product available

    5) Its features fit my needs

    6) It is what I have always owned

4) Think about the following statements: Do you strongly agree, agree, disagree, or strongly disagree?

    1) Technology improves my life

    2) Technology makes me feel safer

    3) I am willing to pay more for the latest technology

    4) I feel comfortable using technology

5) In your home, do you use a device similar to Alexa, Siri, or Google Assistant?

   1) Yes

   2) No

Lifestyle Questions (strongly agree, agree, no opinion, disagree, strongly disagree)

   1) Renewable Energy is something we should invest in.

   2) Electric vehicles are an economical option.

   3) Climate change is real.

   4) Using fossil fuels contributes to climate change.

   5) I am more likely to purchase an electric vehicle if a rebate is offered.

   6) An electric vehicle performs like a traditional gasoline powered vehicle.

   7) I think about the impact my choices have on the environment.

   8) A tax break is an attractive incentive when purchasing an electric vehicle.

   9) I am willing to pay more for a vehicle initially if the actual cost of ownership declines during the vehicle's lifetime.

   10) My community offers multiple charging stations in convenient locations.

   11) I am aware of the different tax incentives and rebates available to electric vehicle buyers.

   12) My next vehicle will be all electric.

   13) I live in an area with reliable public transportation.

Closing Message

Thank you, your time and thoughtful answers are very much appreciated. Your identity is completely anonymous, but your answers will have an impact felt around the world.

Analysis Plan

H1: There is a significant negative correlation between younger adults, and a willingness to purchase an EV

Hypothesis one produces a linear correlation analysis computing the relationship between age (variable data collected demographics under question 2), and data collected by question 12 in the lifestyle

questionnaire (my next purchase will be all-electric) and question 6 in the vehicle preference section (Thinking about your next vehicle purchase how likely are to purchase a...).

H2: Consumers who are willing to pay more than $50,000 on a vehicle will also be more likely to purchase an electric vehicle. To determine hypothesis two's linear correlation data collected from question 3 in the vehicle preference segment (Thinking about how much you paid for your current vehicle, what do you plan to pay for your next vehicle purchase (in US dollars)), question 12 in the lifestyle questionnaire (my next purchase will be all-electric) and question 6 in the vehicle preference segment (Thinking about your next vehicle purchase how likely are to purchase a...).

H3: The higher the level of formal education a person attains the more likely they are to purchase an electric vehicle.

Hypothesis three is tested by running a correlation analysis using data measured in question six from demographics (education) and question 6 in the vehicle preference segment (Thinking about your next vehicle purchase how likely are to purchase a...).

H4: Men are more likely than women to buy an electric vehicle.

Hypothesis four is measures the mean difference (*t*-test) between the grouping variable gender (Men = 1, Women = 2 measured in *demographics* question 3), as it relates to their intention to buy an electric vehicle measured with question 12 in the lifestyle section (My next vehicle will be all-electric) or question six in the vehicle preference segment (Thinking about your next vehicle purchase how likely are to purchase a...).

H5: People who view technology favorably are more likely to purchase an EV

Hypothesis five is tested using multiple correlation. The data set includes the technology questions four and six measuring attitudes towards technology using a five point agree/disagree scale:

1) Technology improves my life

2) Technology makes me feel safer

3) I am willing to pay more for the latest technology

4) I feel comfortable using technology

5) In your home, do you use a device similar to Alexa, Siri, or Google Assistant? (Y/N) and the responses collected by question 12 in the lifestyle questionnaire (my next purchase will be all-electric).

H6: Urban consumers will be more likely to purchase an EV

To test hypothesis six we perform an ANOVA test measuring the grouping variable collected by question eight in demographics(Think about where you live. Would you describe the area as rural, suburban or urban/metropolitan?) measured against responses to question 12 in the lifestyle questionnaire (my next purchase will be all-electric).

Recruitment Plan

This study focuses on the attitudes and intentions of car-buying consumers in the United States, particularly in relation to car technology, climate change, and the potential adoption by the masses of electric vehicles.

Because it appears US consumers in larger Metropolitan areas, particularly along the west coast and N.E. seaboard, are more likely to be concerned about climate change and willing to change their behaviors concerning climate change (Yale) or have already adopted electric vehicles, we'd like to study the attitudes and intentions of Midwestern consumers and EV adoption. For this research paper, we will draw our population from US consumers living in Michigan. Michigan's history with the automotive industry and its regional and economic diversity should provide a rich and representative sampling of Midwestern attitudes and beliefs.

According to US census data, Michigan has a population of 9,986,857, with adults (ages 18 and above) making up approximately 73% of the general population. A further breakdown reveals 75% of adults are white, 14% are black, 5% are Hispanic, 3% are Asian, 3% are two or more races, and 1% are native. Three percent of Michigan residents live in the upper peninsula, 6% live in the northern lower peninsula, 13% live in the eastern central area of the state, 30% live in the western area, and 48% live in the southeastern region of Detroit metropolitan area of the state. In other words, 82% of Michiganders

live in metropolitan areas, 11% live in micropolitan areas, and 7% live in rural areas. Twenty-nine percent of adults hold a bachelor's degree or higher, and 7% of residents are foreign-born.

To ensure a representative population is presented, we asked a random sample of 1,000 Michigan residents to participate in the survey, of which 500 are men and 500 are women. Because we are focusing on the likelihood of electric vehicle adoption/purchase, we are interested in the opinions of current vehicle owners and have included a screening question. One hundred and eighty participants should be aged 65 or older; 290 hold a bachelor's degree or higher. Care was taken to ensure Michigan's distinct geographic regions were represented. Thirty participants were chosen from the Upper Peninsula, 60 from the northern lower region (counties north of and including Manistee, Wexford, Missaukee, Roscommon, Ogemaw, and Iosco), 130 from the central-eastern area (counties east of and including Clare, Isabella, Gratiot, Clinton and north of Shiawassee, Genesee, Lapeer, and St. Clair), 300 from the western part of the state (counties west of and including Osceola, Mecosta, Montcalm, Ionia, Eaton, Calhoun, and Branch), and the remainder chosen from the Detroit metro, southeast area (counties include Ingham, Livingston, Oakland, Macomb, Jackson, Washtenaw, Wayne, Hillsdale, Lenawee, and Monroe). Efforts were also made to ensure representation of Michigan's racial diversity. The five geographic regions were determined using data from the Michigan Economic Development Corporation.

Because available broadband services and technology vary across the state, the survey will be given in person and digitally. Adults participated willingly and were not be compensated for their time. For the purposes of this survey, only adults who currently owned a vehicle were surveyed.

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