FACTORS INFLUENCING ELECTRIC VEHICLE FLEET ACQUISITION IN CANADA: INSIGHTS FROM A RECENT SURVEY

Shakil Khan[1] (corresponding author), Hanna Maoh[2], Mark Ferguson[3] and Moataz Mahmoud[4]
[1,2] University of Windsor, Windsor, Ontario
[3,4] McMaster Institute of Transportation and Logistics, McMaster University, Hamilton, Ontario
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Introduction

Technological advancements in the manufacturing of key Electric Vehicle (EV) components, especially the battery components, have renewed public's interest in EV adoption. These advancements continue to improve the competitiveness of EV vehicles in terms of efficiency and ownership cost relative to gasoline-based vehicles. Governments around the globe are supporting policies that encourage the public as well as commercial entities to consider EV adoption on a more substantial scale. As such, governments and the private sector are responsible for the majority of global EV purchases as reported by Sierzchula (2014). Surprisingly, Canada's global market share of EVs is only 0.4%. (IEA, 2017). This is significantly lower when compared to the European countries such as Norway which leads the globe with a share of 23.3% of global EV market (IEA, 2017).

This paper offers new insights on factors influencing the acquisition of EV fleets in Canada. An online survey was designed to collect information from a random sample of 1,008 Canadian businesses and organizations that own and operate fleets. The collected data included organization's general characteristics, existing fleet characteristics, future acquisition plans and EV fleet prospects. Vehicle fleets were classified into three main types: Cars, Pickup Trucks and Utility Vehicles. The survey tries to identify and understand the factors influencing the preferences and motivations of government and commercial entities as they contemplate adopting EVs in their automobile, pickup truck and utility fleets. The collected data will help identify the circumstances that will lead to higher adoption rates of EVs by these entities.

Survey Design

The online survey was conducted over a course of 9 days between December 7 and 15, 2016. While the survey tool was developed by the authors at the University of Windsor and McMaster University, the data collection was administered by Research Now Inc. (RNI). The latter is a market research company with offices in Toronto, Canada (RNI, 2016). RNI maintains large survey panels with respondents representing Canadian businesses. The survey was designed to be completed within a time period of 15-20 minutes. The survey starts with a preliminary screening page to ensure that the survey is completed by a rightful participant. More specifically, the survey

started with two screening questions as to whether the individual representing the participating organization had the capacity to influence or make decisions about the acquisition of vehicles for his/her organization and whether or not the organization operated some combination of at least 5 vehicles to constitute a fleet. If the answer provided for the two screening questions was 'Yes', the survey would continue and seek further information regarding the type of organization and the best fitting title of the individual representing the organization. On the other hand, if the answer to any of the two-screening questions was 'No', the survey would end. The survey was administrated in six distinct sections. A detailed description of these sections is provided below.

1. Existing Fleet Characteristics

In this section, the respondents (i.e. participating organizations) were asked to provide in-depth details of their existing fleets of Cars, Pickup Trucks and Utility Vehicles (Van, Bucket Truck and Large walk-in Truck). The collected information pertained to the most dominant vehicle class in the above three fleet types. Information regarding fuel type, acquisition condition and ownership status of the existing fleets was acquired. Furthermore, information pertaining to the geographical coverage of fleet operations pertaining to the indicated fleet type (e.g., intercity, inter province, intra province) was obtained. Finally, the respondent was asked to provide fleet usage information such as annual mileage, replacement cycle and average age of the existing fleet.

2. Fleet Acquisition Choice

In this section, the respondents were presented with nine vehicles types, three pertaining to each fleet types listed in the Section 1. For instance, for the Cars fleet, the three vehicle types included Compact Sedan, Intermediate Sedan and Full Sedan. For Pickup Trucks fleet, the choices included Small, Intermediate, and Large Pickup trucks and for the Utility fleets, the three vehicles included Utility Van, Bucket Truck and Large walk-in Truck. The respondents were asked to choose the one vehicle type among the nine choices that would most likely be acquired for their organization's next fleet renewal purchase. Stated preference (SP) scenarios that were presented to the respondent in the next section were customized based on the selection made by the respondents in this section.

3. Stated Preference Scenarios

This section was based on 6 separate SP scenarios that were presented to the respondents one at a time. Each scenario featured 4 different powertrains and associated attributes. After evaluating each vehicle powertrain based on its attributes and features, respondents were asked to choose a vehicle powertrain that their organization would most likely acquire for its fleet. More specially, the 4 powertrain options provided for each scenario included: 1)- Internal Combustion Engine Vehicles (ICEs), ICEs are the most common type of vehicles. They are usually powered by gasoline or diesel fuel, 2)- Hybrid Electric Vehicles (HEVs), HEVs are more fuel-efficient than ICEs, especially within city driving. No charging or plugging-in is required. While idling or travelling at low speeds, HEVs are powered by battery and do not generate tailpipe emissions; 3)- Plug-in Hybrid Electric Vehicles (PHEVs), PHEVs run on both battery and gasoline/diesel. The battery allows short range travel without emissions, while the conventional engine could be used for longer distance traveling; 4)- Battery Electric Vehicles (BEVs), BEVs are powered only by a large battery, resulting in zero tailpipe emission. BEVs can be recharged at home or other designated recharging stations. The SP scenarios included hypothetical vehicle choices with attributes that were broken into 4 major categories: Cost, Incentives, Performance and,

Fueling/Charging Time and Infrastructure. The choice set for each scenario included the four vehicle powertrains of the preferred vehicle size.

4. Electric Vehicle Fleet Prospects

This section was designed to gauge the success and growth prospects of Electric Vehicle (EV) fleet by the government and commercial entities. At the start of this section, respondents were presented with a policy question that pertained to the applicability of any regulatory imperatives in their organizations' fleet procurement. The section also asked respondent about the details regarding future acquisition (if any) of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) for their fleet. This included obtaining information pertaining to the number of vehicles to be acquired, time frame, and condition and acquisition strategy for EV procurement.

5. Organization General Characteristics

A total of 7 questions were asked in this section to identify key characteristics that define the organization and its business needs. This information was collected to understand the nature of the business and its associated transportation needs in a geographical context. Questions pertaining to the best descriptor of the respondent's organization, office location, total number of employees, total fleet locations, total number of Canada-wide employees with daily responsibilities related to the vehicle fleet, and availability of on-site charging infrastructure at all fleet locations were asked in this section.

6. Attitudinal Statements

This section of the survey was subdivided into three sets of statements to gauge attitudes and perceptions of the participating organizations regarding the adoption of Eclectic Vehicles (EVs) in their fleets. In the first set of statements, using a 7 point Likert scale, respondents were asked to express their opinion on factors that deter and support the acquisition of plug-in electric vehicles (BEV or PHEV) for their fleets. Following that, the participating organizations were asked to rate their level of agreement with 11 statements that would reflect their confidence in EV adoption. In the final set, the respondent were presented with 6 statements and were asked to indicate the relative important of different aspects of EVs.

Survey Results

A total of 1,008 organizations completed the survey resulting in a net response rate of 52.74%. The average recorded time to complete the survey was 17 minutes while the median and mode times were approximately 11 and 8 minutes, respectively. In what follows, the results of the full sample of organizations that participated in the survey are presented while focusing on the acquisition of Electric Vehicles (EVs) namely Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) to highlight the factors influencing their acquisition.

General Results

The distribution of participating organizations by sector is presented in Table 1. Commercial or 'For-profit firm' category dominates the sample with a very significant share of 66%. Followed second by 'Non-profit organization' category with a share of 9%. The 'Municipal', 'Provincial' and 'University/College' categories each has a share of 7% in the sample. Lastly, the organizations representing 'Federal' government account for 4% of the total sample.

Table 1 Distribution of Sample by Sector

Sector	Share
For-profit firm	670(66%)
Non-profit organization	88(9%)
Municipal	71(7%)
Provincial	70(7%)
University/college	70(7%)
Federal	39(4%)
Total	1008

A wide range of administrative titles and roles of the representative of the participating organization are observed in the sample. 'Directors' and 'Chief Executive Officer (CEO)' account for nearly 40% of the sample whereas managerial category consisting of 'Fleet Manager' and 'Other Manger' account for nearly 30% of the sample. Nearly 11% of the respondents that participated in the survey are the 'President' of their organizations. The remaining 19% of the sample is represented by 'Chief Administrative Officer (CAO)', 'Fleet Supervisor', 'Chief Financial Officer (CFO)' and' Elected Official' categories.

The results pertaining to the best descriptor of participating organizations are presented in Table 2. As can be seen, a wide range of organization types are observed in the sample with 'Transportation and warehousing' topping the sample with a share of 15% followed closely by organizations belonging to 'Professional, scientific and technical services' and 'Retail trade' categories each with a share of 13% of the total sample.

Table 2 Best Descriptor of Participating Organizations

Best Descriptor of Organization	Share
Transportation and warehousing	154(15%)
Professional, scientific and technical services	136(13%)
Retail trade	132(13%)
Public administration	82(8%)
Other services (except public administration)	70(7%)
Municipal Government Agency	65(6%)
Management of companies and enterprises	52(5%)
Federal Government Agency	51(5%)
Information and cultural industries	39(4%)
Other	227(23%)
Total	1008

In terms of geographic representation, almost 40% of the 1,008 organizations in the sample are located in Ontario (ON) as shown in Figure 1. Quebec (QC) accounts for 20% and ranks 2nd, while British Columbia (BC) ranks 3rd with 12% of the organizations that participated in the survey. Manitoba (MN) accounts for 4% of the total sample while New Brunswick (NB) and Nova Scotia (NS) have the similar representation in the survey with each accounting for 2% of the sample. Finally, the provinces of Saskatchewan (SK) and New Found Land and Labrador (NL) each account for 1% of the total sample.

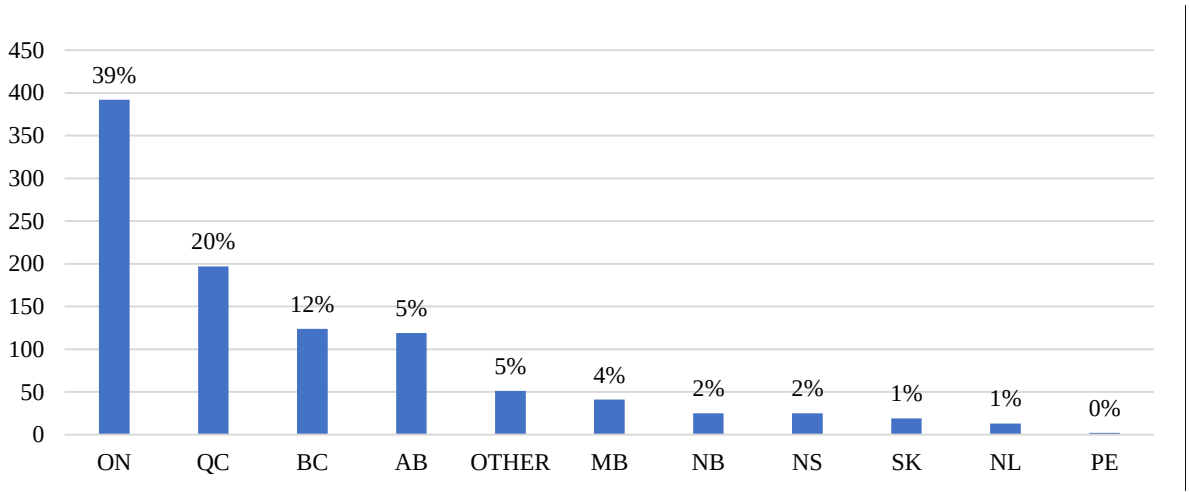

Figure 1 Provincial Shares of Participating Organizations

Table 3 presents the shares of the vehicle types that the participating organizations indicated as the most dominant type in their existing fleets of vehicles. One quarter of the sampled organizations have 'Utility Van' as the most dominant vehicle type in their fleets followed second by 'Intermediate Pickup' with a share of 16% while 'Intermediate Sedan' and 'Large Walk-in Truck' have similar shares (13% and 12% respectively). The same can be said about 'Large Pick' and 'Full Sedan' with shares of 11% and 10%, respectively.

Table 3 Distribution of Dominant Vehicle Type in the Total Sample

Vehicle Type	**Share**
Cars	
Compact Sedan (e.g. Ford Fiesta)	43(4%)
Intermediate Sedan (e.g. Ford Focus)	133(13%)
Full Sedan (e.g. Ford Fusion)	105(10%)
Pickup Trucks	
Small Pickup (e.g. Ford Ranger)	33(3%)
Intermediate Pickup (e.g. Ford F-150)	160(16%)
Large Pickup (e.g. Ford Super Duty)	110(11%)
Utility	
Utility Van	242(24%)
Large Walk-in Truck	123(12%)
Bucket Truck	59(6%)
Total	1008

The remainder of the survey results presented below pertains to the future acquisition of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) and the prevailing attitudes and perceptions toward the adoption of these vehicles. These results are based solely on the response of the 1,008 organizations that participated in the survey.

Electric Vehicle Fleet Acquisition Results

The shares of the 4 vehicle powertrains obtained from the choices made by the respondents in the Sated Presence (SP) scenarios of the survey are presented in Table 4. These choices pertain to the

vehicle powertrains that a participating organization would most likely acquire for its fleet. As expected, ICEs has the highest market share among the four powertrains followed second by HEVs with a share of 29%. The remaining two electrified powertrains, i.e. PHEV and BEVs have shares of 26% and 11%, respectively. These shares reflect the choices that are made in a SP scenarios that allowed the respondents to evaluate potential tradeoffs between attributes and features of the four powertrains. It should be noted that the reported shares of two electrified powertrains are significantly higher compare to the current market shares. For instance, BEV share for Cars and Light Trucks combined is reported as only 0.5% of the total Canadian fleet market (CAF, 2016).

Table 4 Stated Preference Vehicle Powertrain Shares

Vehicle Powertrain	**Cars**	**Pickup Trucks**	**Utility**	**Total Share**
Internal Combustion Engine Vehicles (ICEs)	9%	12%	13%	34%
Hybrid Electric Vehicles (HEVs)	9%	8%	12%	29%
Plug-in Hybrid Electric Vehicles (PHEVs)	6%	8%	12%	26%
Battery Electric Vehicles (BEVs)	4%	2%	5%	11%
Total	28%	30%	42%	100%

Table 5 and 6 present the results pertaining to the acquisition of BEVs and PHEVs, respectively. In the case of BEVs, more than 50% of the participating organizations indicated that they do not have any plan to acquire BEVs for their fleet of vehicles. Organizations that are likely to acquire BEVs for their fleet in the next 2 years have a share of 20% in the total sample, as shown in Table 5. As the time frame to acquire BEVs is projected further in the future, the share of organizations that will likely acquire BEVs drops, i.e. from 16% for the 'In the next 5 years' time frame to 3% for the 'In the next 7 years' time frame. The organizations that were not sure whether they will acquire BEVs for their fleet account for 5% of the total sample. Similar trends are observed among the shares of organizations planning to acquire PHEVs for their fleet.

As for the condition of BEVs and PHEVs in which these two vehicle powertrains will be acquired, the 'New' condition is heavily favored over other all other conditions with shares of 31% and 29% for BEVs and PHEVs, respectively.

Table 5 Acquisition Outlook for Battery Electric Vehicles (BEVs)

BEV Acquisition Outlook			
Time Frame	Share	Condition	Share
In the next 2 years	201(20%)	New	309(31%)
In the next 5 years	159 (16%)	Used	70(7%)
In the next 7 years	35(3%)	Not sure	38(4%)
Not sure when	52(5%)	Mixed	30(3%)
No plans	561(56%)	N/A	561(56%)
Total	1,008 (100%)		1,008 (100%)

Table 6 Acquisition Outlook for Plug-in Hybrid Electric Vehicles (PHEVs)

PHEV Acquisition Outlook			
Time Frame	Share	Condition	Share
In the next 2 years	164(16%)	New	292(29%)
In the next 5 years	156 (15%)	Used	47(5%)
In the next 7 years	33(3%)	Not sure	39(4%)
Not sure when	54(5%)	Mixed	29(3%)
No plans	601(60%)	N/A	601(60%)
Total	1,008 (100%)		1,008 (100%)

Some of the most valuable insights gained from the survey are found in the responses to the attitudinal section of the survey. Due to space constraint, only the results pertaining to the first subsection are presented here. In the first subsection, the respondents were asked if their organizations have any regulatory imperatives or policies (internal or external) in fleet procurement (e.g. 'made in Canada'). Nearly 95% of the participating organizations indicated that they do not have any regulatory imperatives. On the other hand, only 2% indicated that their organizations are bound to acquire North American manufactured vehicles for their fleets.

Next, using a 7 point Likert scale, the respondents were asked to express their opinion regarding factors that deter and support the acquisition of plug-in electric vehicles (BEVs or PHEVs) for their fleets. Some of the key deterring factors included, capital cost, battery replacement cost, charging infrastructure cost (i.e. charging outlets, garage upgrades etc.), operational reliability due to range limitation and longer charging time. On the other hand, the supporting factors included reduced fuel and maintenance costs, monetary incentives including municipal & provincial incentives, access to High Occupancy Vehicles (HOV) lanes, and availability of free parking on municipal lots. The average responses to these two categories of factors are presented in Figure 2. On average, 23% of the organizations indicated that the deterring factors are 'Extremely Important' in the acquisition of BEVs or PHEVs for their fleets. Similar trend is observed for factors that support the acquisition of BEVs or PHEVs with nearly 25% of the organizations indicating those factors to be also 'Extremely Important' in their fleet acquisitions. On the other hand, an insignificant proportion of the organizations considered the two categories of factors to be 'Not at all important' in the acquisition of BEVs or PHEVs for their fleets. It is important to note that a vast majority of the organizations (above 90%) agree that both categories of factors are in some form or not important in the acquisition of BEVs or PHEVs for their fleets.

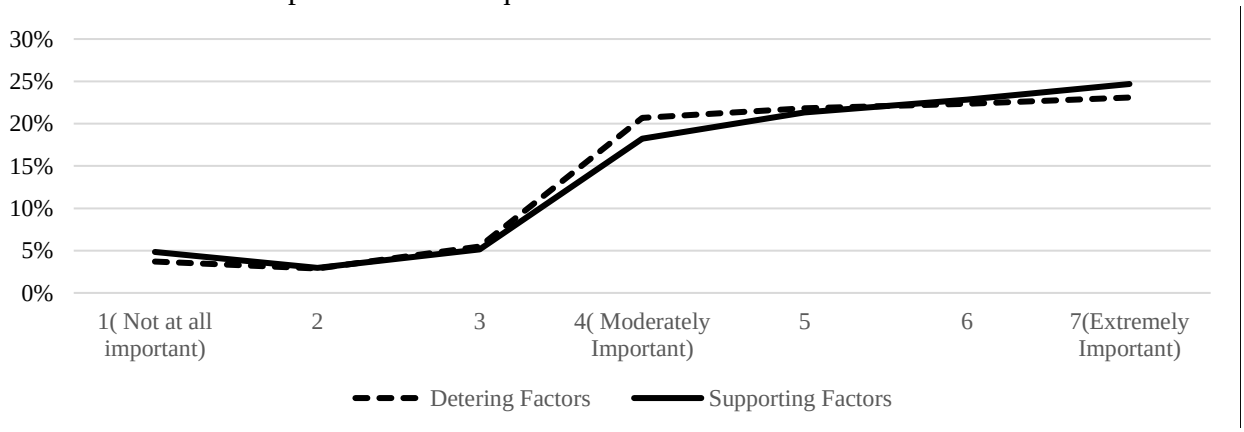

Figure 2 Average Responses Regarding Factors that Deter and Support EV Acquisition

Summary and Future Work

This paper presented the results from an online survey that collected information from a random sample of 1,008 Canadian organizations that own and operate fleets. The objective was to evaluate the future of Electric Vehicle (EV) adoption by government and commercial organizations in Canada. The collected data included organization's general characteristics, existing fleet characteristics, EV future acquisition plans and prospects. Fleets were classified into three main types: Cars, Pickup Trucks and Utility Vehicles. The survey featured a Stated Preference (SP) section to evaluate the future of electric mobility in Canadian fleets. Conventional gasoline based vehicles had the highest market share among the four vehicle powertrains followed second by Hybrid Electric vehicles with a share of 29%. The Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs) had shares of 26% and 12% respectively. Nearly 20% of BEVs and 16% of PHEVs were reported to be acquired within a 2 years' time frame. Among the three acquisition conditions that the two electrified powertrains could be acquired, the 'New' condition had the highest share (31% and 28% for BEVs and PHEVs, respectively). The survey also focused extensively on gauging attitudes and perceptions of the participating organizations towards the critical factors that either support or deter EV fleet acquisition. Overall, the survey results are timely and provide novel insights on how Canadian organizations acquire their gasoline-based fleets in general and electrified vehicles powertrains in particular.

For the future work, the collected SP data will be used to develop advanced discrete choice models to identify the factors that will lead to higher adoption rates of EV's by government and commercial organizations. The results to be achieved from the conducted analysis are expected to assist stakeholders in their efforts to evaluate the social and economic benefits of introducing and using EVs in fleets owned and operated by various Canadian markets.

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References

CAF (2016). Canadian Automotive Fleet *Annual Fleet Fact Book 2016*. Available at: http://bluetoad.com/publication/?i=295795#{"issue_id":295795,"page":8} Last accessed: March 11, 2017.

IEA (2017). International Energy Agency. Global EV Outlook2016: Beyond one million electric cars. Available at: http://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf Last accessed: March 22, 2017.

RNI (2016). Research Now Inc. Our work. Available at: https://www.researchnow.com/our-work/ Last accessed: March 22, 2017.

Sierzchula, W. (2014). Factors influencing fleet manager adoption of electric vehicles. Transportation Research Part D 31 , 26–134.