A FRAMEWORK FOR COLLECTING STATED PREFERENCE DATA ON ELECTRIC VEHICLE (EV) ADOPTION BY THE CANADIAN FLEET OPERATORS

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Introduction

The stated-preference approach is a popular choice among transportation modelers to generate behavioral data. It employs scenarios with hypothetical, yet probable, situations which are generated through methodical and planned design processes (Louviere et al. 2000). This allows the individual making the choice (i.e. decision-maker) to compare multiple alternatives encased within a single scenario, each described in terms of varying attributes, and requiring an elicited response from the decision maker. The behavioral data acquired through this method can be used to evaluate the willingness-to-pay (WTP) estimates of the modeled decision makers for choosing a specific alternative.

Technological advancements in the manufacturing of key Electric Vehicle (EV) components, especially the battery components, and the heightened climate change awareness have renewed public's interest in EV adoption. These advancements have been focused on extending the trip range, lessening the charging time and lowering the capital cost to own an EV. 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).

Given the infancy of the EV market penetration in general and in Canada in particular, there is ample of room for research to explore the potential social and economic implications of marketing EVs. This paper contributes to this area of transportation research by

outlining a framework for collecting attribute-based stated preference data on the acquisition of EVs by Canadian commercial fleet operators. The collected data will server as an input to advanced discrete choice models that will be used to quantify the determinants of EV fleet vehicle purchases by government agencies and commercial entities.

Review of Stated Preference and Willingness-to-Pay (WTP) Methods

Stated Preference (SP) method is frequently used to assess how decision makers react to a change in levels of service of an alternative or to the introduction of an additional hypothetical alternative in the choice set (Hidrue et al. 2011). The contemporary design of SP methods in transportation research is catered for the development of discrete choice models. In the latter, alternatives can be described in terms of their characteristics and attributes rather than their whole value.

The review of the relevant academic literature suggests that the use of this particular approach is in ascendency as it provides a close replication of the situations decision makers normally face in everyday life while choosing a single option from a set of choices. Our literature review suggests that most of the earlier SP studies undertaken to assess the adoption of Electric vehicles (EVs) were conducted in response to an event or act that had transpired in recent past. For example, the efforts by Beggs et al. (1981) and Calfee (1985) were in response to the 1970's oil crisis. Low market representation of EV and limited trip range anxiety were the two most important concerns reported in the results by these studies.

During the early 1990s, the introduction of the zero-emission vehicle mandate by the State of California (as first enacted in 1991) inspired many researchers to conduct work to predict the potential EV demand in this American state. Some of these studies include the work of Bunch et al. (1993); Golob et al. (1997); Brownstone and Train (1999) and Brownstone et al. (2000). Later on, the work by Ewing and Sarigollu (2000); Dagsvike et al. (2002) and Batley et al. (2004) identified various key factors that affect the adoption of EVs, which

included reliability, limited trip range, longer charging hours, high purchase and maintenance cost. The results from these studies also pointed to a low probability of EV adoption among conventional gasoline vehicle users.

The focus on using more energy efficient transport technologies and reducing the dependence of fossil fuel in the new millennium has led to another wave of studies on the adoption of Alternate Fuel Vehicles (AFV). These studies also estimated the willingness-to-pay (WTP) for specific types of AFVs by relying on SP data (see for example: Potoglou and Kanaroglou, 2007; Mau et al. 2008 and Train, 2008). The results from these studies suggested that the limited availability of fueling stations will have a strong negative effect on the choice of AFVs. Potoglou and Kanaroglou (2007) and Hidrue et al. (2011) reported that the WTP for emission reduction is noticeably high when it comes to selecting AFVs. On the other hand, results from the study by Dimitropoulos et al. (2013) pointed to the existence of significant heterogeneity among decision makers in the WTP estimates for EV trip range.

Canadian Fleet Characteristics

To assess the determinants of Electric Vehicle (EV) adoption by business fleets it is important to identify key features of the existing fleet operations including fleet sectors, types of vehicles acquired by these sectors, types of fuels these fleets run on and the jurisdiction they are acquired in. The following subsections highlight the characteristics of the Canadian fleet as reported in the 2014 Canadian Automotive Fleet (CMA) annual fleet fact-book (CMA, 2014). The reported figures are based on the 2013 POLK data (IHS, 2015). All figures were adapted from the aforementioned fact-book.

Fleet Registration by Province/Territories

The breakdown of total fleet registrations (Car and Light Tuck) for the year 2013 by jurisdiction is provided in Figure 1. Ontario has the largest share of fleet registration among all jurisdictions followed by Alberta and Quebec with shares of 21.58% and 17.37%, respectively. Fleet registrations in the province of British Columbia account for

nearly 12% of Canada's fleet registrations. The Maritime provinces (i.e. New Brunswick, Nova Scotia and Prince Edward Island) account for nearly 6% of total fleet registrations.

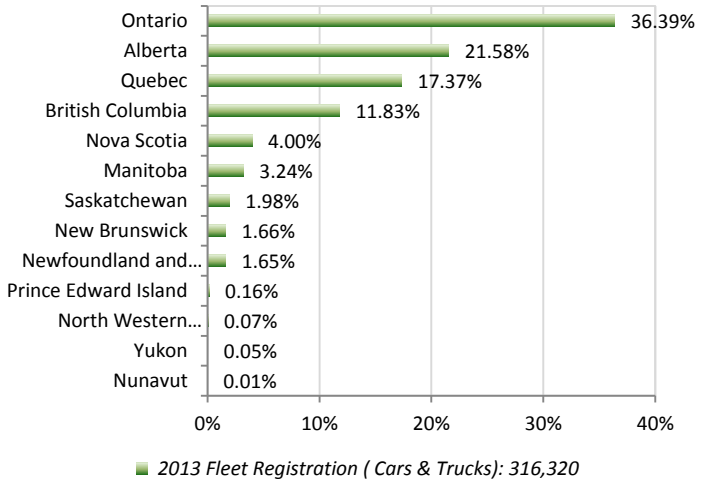

Figure 1. Fleet Registration by Province (Car and Light Truck)

Fleet Registration by Sector Type

The 2013 fleet vehicles registrations consist of two main categories: Cars and Light Trucks. The breakdown of fleet registrations by sector type is presented in Figure 2.

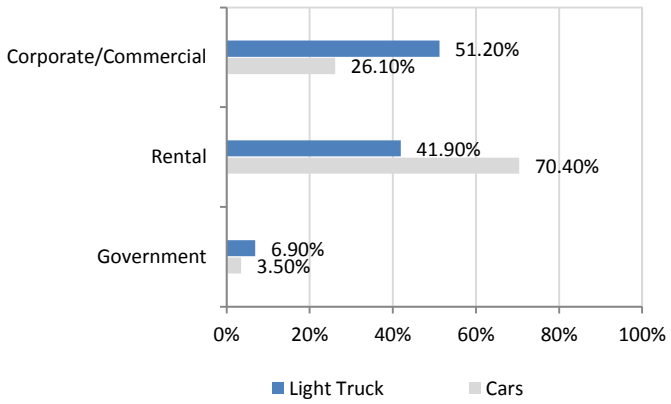

Figure 2. 2013 Fleet Registration by Sector Type

In the case of cars, the rental industry accounts for nearly 70.40% of all car fleet registrations followed by the Corporate/Commercial sector with a little over quarter of the total car registrations (26.10%) in 2013. The government sector only accounts for a small fraction of the reported car registrations (3.50%). On the other hand, the corporate/commercial sector has the highest representation of a little more than half of the total 2013 truck fleet registrations (51.20%) followed by the rental sector with a share of nearly 42%. Consistent with the low shares observed for car registrations, only 6.9% of the total light truck registrations were reported for the Government sector.

Fleet Registration by Fuel Type

Conventional fuels dominate the 2013 car fleet registrations, as shown in Figure 3. Nearly 82% of all registered cars are gasoline powered. Cars running on flexible fuels account for nearly 14% of the total registrations. Electric cars are only a handful of 0.01%. Nearly 47% of the light truck registrations are gasoline based. However, an interesting observation is the share of light trucks running on flexible

fuels which amounts to nearly 46% of the total truck registrations. Light trucks running on more conventional fuels such as diesel account for a little over 7% whereas there are no registrations reported for electric powered light trucks in the 2013 fleet registrations.

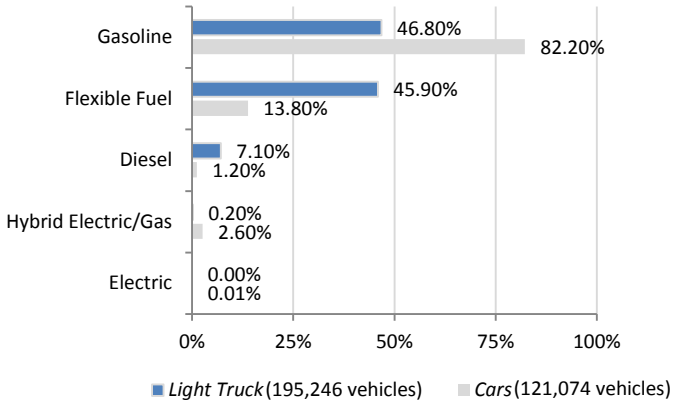

Figure 3. 2013 Fleet Registration by Fuel Type

Fleet Registration by Vehicle Type

The breakdown of Car registrations based on its sub-categories is presented in Figure 4a. Intermediate size (often referred to as mid-size) cars account for nearly 43% of the total registrations followed by compact and subcompact types with registration shares of 34.80% and 12.30% respectively.

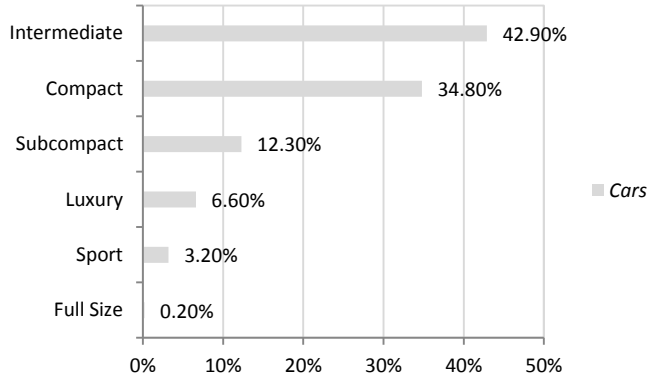

Figure 4a. 2013 Fleet Registration by Vehicle Type - Cars

Fleet registrations for different categories of Light Truck are presented in Figure 4b. The "all pickups" category accounts for 38.40% while the SUV (including Compact) accounts for nearly 41% of total registrations. The registration shares of small and large vans are about 12% and 9% respectively.

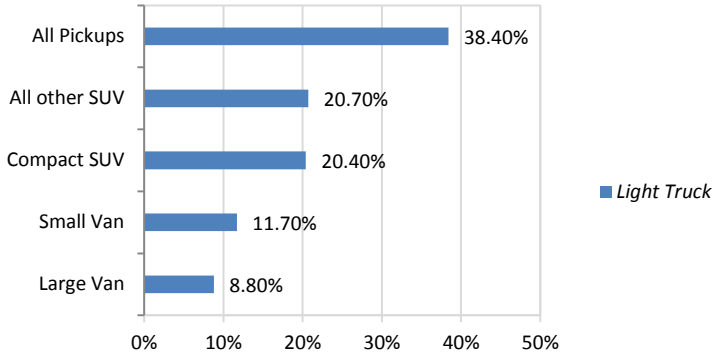

Figure 4b. 2013 Fleet Registration by Vehicle Type – Light Truck

Proposed Framework for Collecting Stated Preference (SP) Data

The proposed framework for collecting SP data on Electric Vehicle (EV) adoption by the Canadian fleet operators is shown in Figure 5.

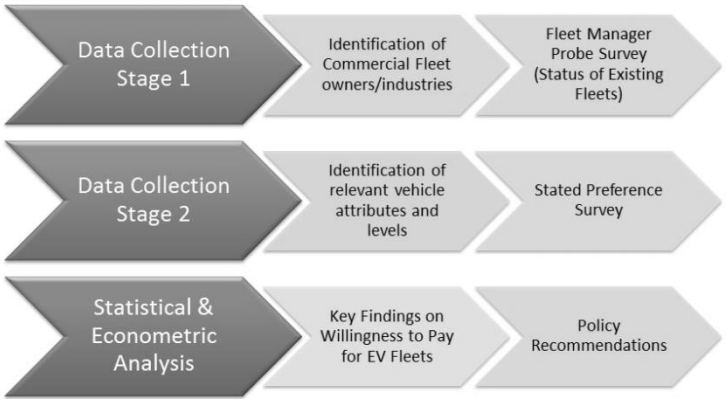

Figure 5. Research Process of Electric Vehicle (EV) fleet Adoption

Identification of potential industries and sectors owning and operating commercial fleets is the first stage of the proposed framework. Eight different sectors presented in Figure 6 are identified for this purpose. The figure also shows the possible nature of businesses operating under each sector.

Following the identification of the sectors to be introduced in the analysis, a fleet manager probe survey will be conducted to gather insights about the underlying decision making process of the acquisition of the commercial fleets by Government agencies, municipalities and other commercial entities. The main elements of this probe survey are presented in Figure 7. These include collecting information about establishment characteristics, details of conventional and non-convectional fleets and characteristics describing the fleet utilization. The information obtained from this survey will then be used to identify the most relevant vehicle attributes and functions pertaining to the fleet acquisition process.

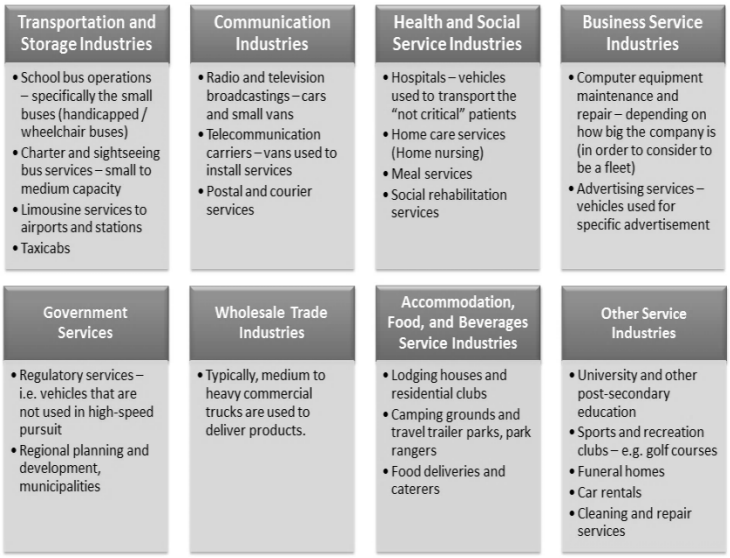

Figure 6. Possible Industries Owning and Operating Commercial Fleets

Reflecting on the trends reported in the 2013 Canadian fleet registrations by CMA (2014), the scope of the sectors/industries will be limited to the three main categories of fleets (i.e. Government/Municipal fleets, Corporate/Commercial fleets and Rental fleets). Accordingly, a list of variables with their associated attribute levels relevant to the fleet needs of the above sectors will be formulated. The formulated variables will form the basis for the design of a Stated Preference Survey (SPS). These variables will be categorized under three main headers namely: 1) Key Considerations, 2) Key Benefits, and 3) Adoption Impediments, as shown in Figure 8.

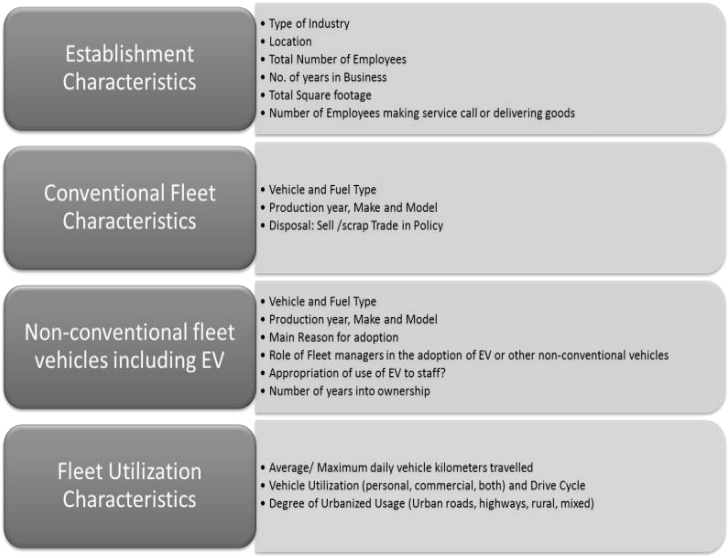

Figure 7. List of Variables Forming the Basis of the Fleet Manager Probe Survey

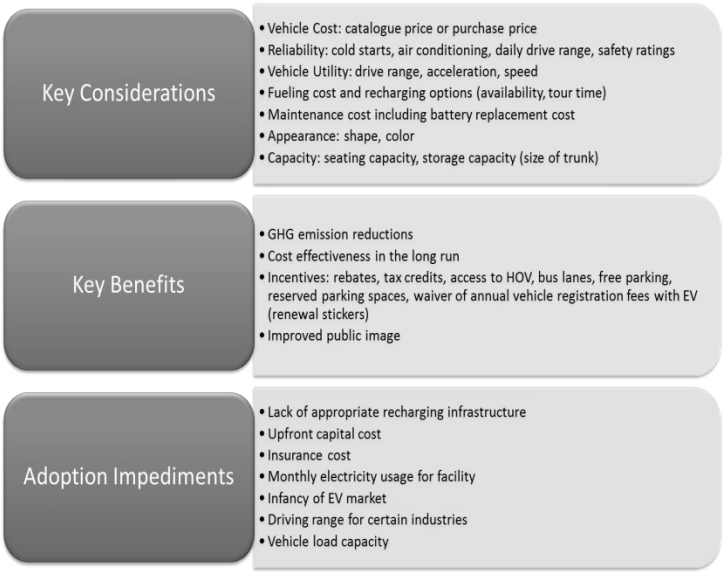

Figure 8. List of Variables Forming the Basis Stated Preference Survey

The research will use a SP design suitable for conducting discrete choice modeling with the collected SP data. The objective of the instrument is to collect data that can be used to assess the adoption of EV technology among fleet operators. To identify the intrinsic preference functions the Fractional Factorial Technique (FFT) will be used to minimize the number of alternatives, attribute levels in a given scenario and number of the scenarios presented to the decision maker. This will also ensure that the user fatigue is minimized. Figure 9 shows an example of one such scenario.

Features	Alternatives			
	Vehicle 1 (GV)- Base	**Vehicle 2 (HEV)**	**Vehicle 3 (PHEV)**	**Vehcile 4 (BEV)**
Catalogue Price($)	25000	30000	35000	40000
Annual Fuel Cost($)	3000	2500	1500	500
Annual Maintenance/Operation cost (including Insurance)($)	1800	2000	1500	800
Depreciation Rate (per year)	10%	8%	6%	4%
Warranty	5 years / 100,000km	8 years, 160,000 Km	3 years/60,000 km	8 years, 160,000 Km
Incentives	None	No HST	Free yearly registratoin	Free City Parking
Total Daily Drive Range (Electric Only Range)	N.A	50km	75km	100km
Time for 100% Recharge for BEV	N.A	N.A	Level 1 : 11 to 20 hours	Level 3: 20-30 min
Tail pipe Emissions	Base	-10% of Base Case	-20% of Base Case	-75% of Base Case
Accessibility to fueling station (Recharging Stations etc.)	Base	N.A.	+5% of Base Numbers	+10% of Base Numbers
Vehicle Class	Compact	Full Size	Small Van	Small Pickup
Vehicle Procurement Method	100% Upfron Payment	Leasing	Financing	Other
Your Choice of Vehicle	□	□	□	□

Figure 9: Sample Choice Scenario in the Stated Preference Survey

Using the data collected through the SPS, advanced statistical and econometric techniques will form the final module of the proposed framework to estimate the willingness-to-pay (WTP) measures for the adoption of EVs by Canadian fleet operators.

Excepted Results

It is expected that the execution of the proposed framework will result in the collection of high quality data reflecting the true decision making process involved in the acquisition of vehicle fleets by various entities such as Government, Corporate/Commercial and Rental sectors. The collected data will offer researchers the opportunity to develop a full-bodied behavioral model to assess the determinants of the Electric Vehicle (EV) adoption by Canadian fleets. 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 various Canadian markets.

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