



Factors affecting electric vehicle sharing program participants' attitudes about car ownership and program participation



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ABSTRACT

There are growing concerns on traffic congestion, climate change and parking problems in major cities. Faced with these concerns, policy makers have sought sustainable transportation options including electric vehicle sharing programs (EVSPs). The city of Seoul with 10 million people also has recently launched an EVSP to provide citizens with an alternative travel mode. This study attempts to explore factors affecting the EVSP participants' attitudes about car ownership and program participation. To do this, a web-based survey was conducted for the participants of the Seoul EVSP, asking their satisfaction levels for the components of the EVSP. Then, using 533 responses of 1772 EVSP members (a response rate of 30%), ordered probit models were developed for three types of attitudes: (1) willingness to dispose of a car, (2) willingness to purchase an EV and (3) willingness to continue participating in the EVSP. The estimated models suggested that participants' social and economic perspectives were the most important factors affecting the participants' attitudes. In addition, the attitudes varied depending on personal characteristics such as gender, age and income. Although this study was conducted in the early stage of an EVSP, its results are expected to provide insights into a better EVSP design.

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Introduction

Electric vehicles (EVs) have become widely recognized as an environmentally friendly mode of transport. Along with this aspect, most car manufacturers have started to develop and commercialize EVs, especially targeting the urban market (Sierzchula et al., 2012). Some previous studies have shown that EVs can reduce local air pollution and traffic noise (Brady and O'Mahony, 2011; Hawkins et al., 2013), and may improve the sustainability of the road transportation sector which is responsible for the largest share of transportation carbon emissions (Brouwer et al., 2013).

In recent years, the popularity of car-sharing has grown in several large cities (Stasko et al., 2013) due to its benefits such as saving the costs of car purchase and maintenance and reducing parking demand (Efthymiou et al., 2013). Car-sharing can be classified into three types: neighborhood car-sharing, station cars and multi-nodal shared use vehicles (Barth and Shaheen, 2002). Appropriate models can be selected depending on the conditions of the city. Martin and Shaheen (2011a) reported that there are some positive effects of car-sharing operations. They insisted that car-sharing can induce people to abandon their cars by giving access to an automobile only when needed, and providing some benefits from eliminating costs of owning a private vehicle. They also argued that the service improves fuel efficiency because vehicle fleets for

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car-sharing tend to be composed of more fuel efficient cars such as hybrid cars. A more comprehensive review on car-sharing including its history is found in [Shaheen and Cohen \(2007\)](#) and [Shaheen et al. \(1998\)](#).

Since EVs are typically well-suited for use in cities, many city governments are attempting to implement EV sharing initiatives in numerous ways by providing financial supports ([Bakker and Trip, 2013](#)). Some cities in European countries such as Barcelona, Paris, Berlin, Hamburg, Rotterdam and Stockholm are implementing EV car-sharing programs ([IEA, 2012](#)). Since the use of EVs for car-sharing is a recent application, most EVSP-related studies utilize data from experimental level small programs rather than a city-wide scheme ([Luè et al., 2012](#); [Nakayama et al., 2002](#)). The EV car-sharing program allows many people to gain experience with driving EVs, which may be useful for educating the public about the technology and its usability. In accordance with these trends, the city of Seoul, the biggest city in South Korea, had just officially started an EVSP in May 2013. The program aims (a) to mitigate traffic congestion; (b) to take actions on climate change; and (c) to alleviate parking problems by reducing car-ownership of citizens. Since the beginning of the EVSP, many citizens have registered their membership and experienced EVs through the service.

To help policy makers, this study investigates which factors affect the EVSP users' attitudes about environment-friendly and sustainable travel mode choices after participating in the EVSP and experiencing EVs. For this, this study conducts a survey asking the EVSP users about their satisfaction degrees for each EVSP component. Then, the components are grouped by using a factor analytic technique in order to figure out which factors are closely related. Next, to analyze which factors will affect the EVSP users' attitudes, ordered probit models are estimated with dependent variables of three types of intentions: willingness to dispose of a vehicle, to buy an EV and to continue using shared EVs. The paper discusses the implications on the findings and provides recommendations for future research and policies. The results of the investigation are expected to be useful for policy makers who are to efficiently operate and expand an EVSP, formulate EV transportation systems and promote citizens to purchase EVs.

The electric vehicle sharing program in Seoul

In Seoul, public transit is the most frequently used transportation mode as suggested by the mode shares: 24.1% of passenger car, 28.1% of bus, 36.2% of metro, 7.2% of taxi, and 4.4% of others as of year 2010. However, still a significant portion of trips are made by personal cars because of the lack of accessibility to public transit for some areas, aggravating traffic congestion ([Kim et al., 2014](#)). In addition, parking problems are very severe for some old residential areas where developers failed to provide sufficient parking spaces meeting the sharply increased car-ownership. Under this circumstance, the city government has strengthened parking requirements. For example, 20 years ago, developers did not need to provide parking lots for houses with a floor area of less than 200 m², but now they must provide at least one parking lot even for those houses. In spite of the measures, some communities with old houses still face a severe problem of parking supply shortage. In the case of Gangbuk-gu, an old residential area, the ratio of the numbers of parking lots to registered cars is only 0.64 as of 2011.

To mitigate these problems, Seoul Metropolitan Government (SMG) contracted with four private companies for the operation of an EVSP and officially launched the program in May 2013 after a ten month pilot test. During the pilot test period, the EVSP was widely promoted to citizens and the renting systems became stabilized. SMG together with the central government supported the companies by providing an EV purchase subsidy (about 15,000 USD for each government), enabling them to buy the vehicles at the same level of cost as conventional vehicles. In addition, SMG allowed the use of city-owned parking spaces for their car-sharing stations with a discounted parking rate of 50%. At the initial stage, the EVSP deployed 132 all-electric vehicles (Kia Ray EVs, one single EV model at the time of deployment) with 59 car-sharing stations as seen in [Fig. 1](#). The Ray EVs are equipped with a 16.4 kW h lithium ion battery that allows an all-electric range of 138 km depending on driving conditions. Their charging time is about six hours for standard chargers and 25 min for high-speed chargers. The drivers can recharge the EVs using 160 free public chargers including 28 high-speed battery chargers installed at car-sharing stations and some public buildings such as city hall.

At the end of the year, the EV fleet size increased to 184 with 87 car-sharing stations. Most car-sharing stations are located near metro stations in the business or commercial areas so as to provide public transit users with good accessibility to and from the shared EVs, filling the gap between personal cars and public transit. The members of the EVSP can access the shared EVs at any time with a reservation through the EVSP website or smart-phone applications. The online system provides the members with the real-time information about the battery charge state of the shared EVs to be rent as well as their availability. The rental fee is assessed by adding two elements: basic fare (about 5.0 USD per hour including insurance) and distance-based fare (15 cents per kilometer). If a member travels 13 km (the average trip length of a Seoul citizen) using a shared EV within an hour, the rental fee is about 7.0 USD, which may be compared with a taxi fare of 10.0 USD and a public transit fare of 1.1 USD for the same distance trip.

Data

Survey

The research team developed a website for conducting a questionnaire-based survey to identify participants' attitudes about the EVSP. The web-based survey is advantageous in that it minimizes the occurrences of missing answers by advising

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