AESC Working Paper 18

How to Mainstream Electric Vehicles in Hong Kong: The Importance of Early Adopters

Tsz Kiu Lee[1, 2]
Daphne Ngar-Yin Mah[1, 2]

Publication Date: 9-2017

[1] Department of Geography, Hong Kong Baptist University
[2] Asian Energy Studies Centre, Hong Kong Baptist University

Correspondence to lead author: Daphne Ngar-Yin Mah, daphnemah@hkbu.edu.hk.

How to Mainstream Electric Vehicles in Hong Kong: The Importance of Early Adopters

Abstract

Electric vehicles (EVs) has been regarded as a major technological option for sustainable futures among many nations. Past studies indicated that early adopters played an important role in energy technology innovation. A range of policies are implemented by nations as motivations for early adopters. Although Hong Kong has its first EV policy implemented in 1994, its EV market share in previous decades was far behind the other countries. This paper presented an in-depth qualitative analysis of 15 EV early adopters and 2 informants in Hong Kong to explore the motivation of local consumer and their experience, hence discover the limitation of the current EV policies in Hong Kong. The response of participants indicated that cost was the primary concern for the early adopters, while situational factors is more influential than other factors. Besides, early adopters concern much on the availability and convenience of the chargers, thus, managerial and institutional barriers, especially on the public chargers, hindered the wide adoption of EV in Hong Kong.

Table of Content

Page

List of Tables

List of Figures

List of Maps

1. Introduction

Electric vehicles (EVs) is a green transport that emerged back in last century. However, it became popular since 21st century due to advanced battery technology, which is the spirit of EV development. The rising concerns on environmental issues in recent years give rise to the green commercial and personal transportation (Ross Marlin Green; Michael John Kellaway, 1997). Global warming is highly concerned by the world. Transport sector is one of the few industrial sectors which emissions is still growing and vehicle emission is one of the major source of greenhouse gases (Lee, 2007).With zero emission, EV is considered to be a powerful tool for mitigation of climate change (Regional Environmental Center, 2004).

Hong Kong is suffered from serious air pollution, particularly roadside pollution, and heat island effect in urban areas. There was a total of 244,730 tonnes of air pollutants emitted by different sources in 2014 (EPD, 2016). Secondary to water navigation, which account for 28%, road transport account for 27% of the total emission. Considering the roadside monitoring stations located at Mong Kok, Causeway Bay and Central, which record the level of air pollutants along the major roads, the pollutants kept a steady but high level in 2011 to 2014.

During these five years, the average annual amount of air pollutants of Fine Suspended Particulates (PM_{10}), Respirable Suspended Particulates ($PM_{2.5}$), Nitrogen dioxide, Ozone, and Sulphur Dioxide at the three roadside monitoring stations are 36μg/$m^{3,}$ 70, μg/m^3 116μg/m^3, 16μg/m^3, and 10μg/m^3 respectively. However, according to the air quality guidelines for key air pollutants set by World Health Organization (WHO), the first three air pollutants mentioned above should not exceed 20μg/m^3,10μg/m^3, and 40 μg/m^3 annual mean respectively, Ozone should not exceed 100μg/m^3 8-hour mean, and Sulphur Dioxide should not exceed 20μg/m^3 24-hour mean (WHO, 2006).

According to the Hong Kong University's Hedley Environmental Index, there were more than 2000 premature deaths in 2014 due to the poor air quality in Hong Kong (The University of Hong Kong, 2017). It shows a huge cost to the society with a poor ambient air quality in Hong Kong. People who stay outdoor when the air quality level exceed WHO air quality guidelines levels are exposed to a higher health risk, leading to higher chance suffering from cardiovascular and respiratory diseases. The Particulate Matter (PM) has even

being classified as carcinogenic to humans by The International Agency for Research on Cancer.

To reduce the health risk of Hong Kong citizens for suffering from cardiovascular and/or respiratory diseases, it is essential to improve the ambient air quality, especially the roadside air quality. According to WHO (WHO, 2006), investments and policies supporting cleaner transport can reduce key sources of urban ambient air pollution. EV, thus, is a potential green transport technology to alleviate the ambient air pollution problem by reducing roadside emission in Hong Kong.

There were researches working on the barriers and limitation of current EV development in Hong Kong. However, there were lack in analyzing the experience of early adopters. This leads to an incomplete picture on the analysis of the consumer preferences and deviation on policy recommendation. To include experience of early adopters for a precise and accurate analysis, this research aims to: 1) examine current EV deployment in Hong Kong; 2) identify the influential factors, including motivations and concerns, on purchase decision of EVs early adopters; 3) define major concerns of early EV adopters in Hong Kong after experiencing.

2. Global EV Development

2.1. EVs: A Global Overview and a Case Example of Norway

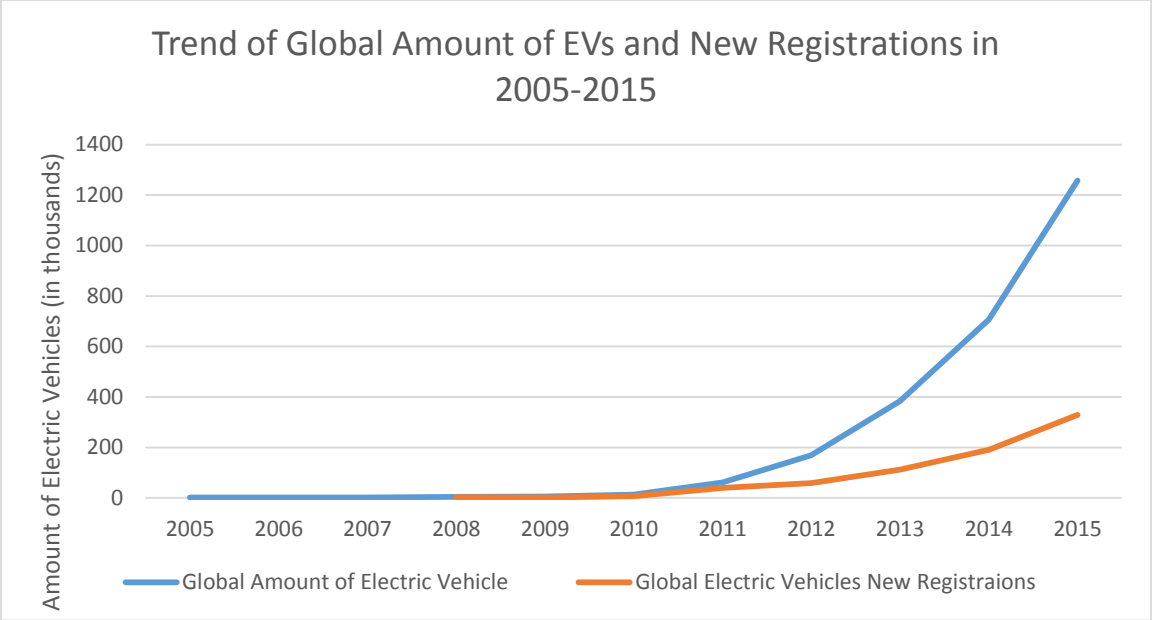
2.1.1. An Overview of the Global Developments of EVs

By 2015, there were over 1.25 million EVs globally[1] (IEA, 2016). The amount of EVs, new registration, and market share in different countries is rising significantly. Starting from 2005, there were statistics by country on the above three dimensions. From 2005 to 2010, the global amount of EVs was nearly invisible (Figure 1). The year 2010 was the turning point of EVs global development, whereas the amount of EVs started to increase. Since then, the amount of EVs increase sharply every year. The global amount of EVs new registrations showed a positive relationship with the amount of global EVs. From 2008 to 2010, the global EV new registration number kept at a level which was nearly invisible (Figure 1). Starting from 2010, the number of global EVs new registration rise rapidly with the global amount of EVs.

The data of market share of EVs in the world was available since 2008 (Table 1). From 2008 to 2015, the global market share of EVs increased from 0% to 0.9%. Norway was the most outstanding country, which increased 23.1% of its EVs market share in 7 years. The market share of EVs in Norway was 0.2% in 2008 when it was first recorded. Until 2015, Norway was far in front of the others which owned a EVs market share of 23.3%.

[1] Global refers to countries as follows: Canada, China, France, Germany, India, Italy, Japan, Korea, Netherlands, Norway, Portugal, South Africa, Spain, Sweden, United Kingdom, United States, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Turkey

Figure 1: Trend of Global Amount of EVs and New Registrations in 2005-2015



Source: Author, Data: (IEA, 2016)

For other countries, the first data of their market share of EVs were recorded between 2009 and 2011. The Netherlands came second which own 9.7% of EVs market share in 2015, though was far behind Norway. Most of the countries owned less than 1% market share of EVs. European countries were more outstanding than Asia and North American countries. European countries account for the largest EVs market share in the world. In Asia, China owned the largest market share of EVs, which was 1.0%. Japan and Korea owned a smaller EVs market share of 0.6% and 0.2% respectively. India owned an even smaller market share than the three Asian countries above. Countries in North America also did not own a large market share as Europe, whereas the United States and Canada owned 0.7% and 0.4% respectively.

Table 1: Market share of Electric Vehicles by Country in 2005-2015

		2008	2009	2010	2011	2012	2013	2014	2015
Europe	Germany				0.1%	0.1%	0.2%	0.4%	0.7%
	Netherlands			0.0%	0.2%	1.0%	2.5%	3.9%	9.7%
	Norway	0.2%	0.1%	0.3%	1.5%	3.2%	5.8%	13.7%	23.3%
	Sweden				0.1%	0.3%	0.5%	1.4%	2.4%
	United Kingdom				0.1%	0.1%	0.2%	0.6%	1.0%
Asia	China			0.0%	0.0%	0.1%	0.1%	0.4%	1.0%
	India			0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
	Japan		0.0%	0.1%	0.4%	0.5%	0.6%	0.7%	0.6%
	Korea				0.0%	0.1%	0.1%	0.1%	0.2%
North America	Canada				0.0%	0.1%	0.2%	0.3%	0.4%
	United Stated			0.0%	0.1%	0.4%	0.6%	0.7%	0.7%
Globally		0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.5%	0.9%

Source: Author, Data: (IEA, 2016)

2.1.2. EV policies in different countries

The countries with large market share of EV list in Table 1 have a wide range of effective governmental policies, motivating the consumers purchase EVs. The policies, as listed in Table 2, are set in four dimension: 1) EV purchase incentives, 2) EV circulation incentives and driving privileges, 3) subsidy for charging infrastructures (Amsterdam Roundtable Foundation, McKinsey & Company, 2014) (IEA, 2016).

From Table 2, it can be seen that the countries provide large amount of subsidy to reduce the initial cost of the vehicle. The governments also provide various driving benefits and circulation tax exemption to reduce the lifetime cost and provide convenience for EV drivers in a large extent.

Table 2: Summary of EV Policies of Countries with Large Market Share

	Amsterdam, the Netherland	London, the United Kingdom	Oslo, Norway
Subsidy per EV (on purchase price)	• EUR 5,000 / 10,000 / 40,000 for passenger car / taxi1 / truck	• 25% (up to EUR 5,699) off	• Exempt from 25% VAT and purchase tax (up to EUR 17,000)
EV benefit	• No waiting list for parking permits • 4 parking garages with free charging • Exempt from registration tax and annual circulation tax	• Exempt from congestion charge and road tax	• Exempt from all non-recuring vehicle fees, including road tax • No parking fees or toll payments • Access to bus & taxi lanes
Subsidy for charging infrastructures	• The Netherlands currently has roughly 1.1 charging stations per vehicle, the most EVSE per capita worldwide • Government introduced tax incentives to support creation of charging infrastructure	• EUR ~44 million for charging points for residential, street, railway, and public sector locations (available until 2015, plans to install 13,500 domestic and 1,500 on-street points)	• EUR 1,200 as a subsidy if you put up a EV charging station

Source: Author, Data: (Amsterdam Roundtable Foundation, McKinsey & Company, 2014)

Oslo, the capital of Norway which own the largest market share of EV in the world, has its EV policies implemented 10-15 years in both local and national level. The policies were integrated into the Climate Agreement by the Norwegian Parliament (Bjart Holtsmark, Anders Skonhoft, 2014). Oslo government provides a subsidy on EV purchase far more than other countries. EVs are exempt from all non-recurring vehicle fees, including VAT, registration tax, and sales tax (exclude VAT) (Walter Leal Filho, Richard Kotter, 2015). The government also encourage companies to use EVs by providing tax benefit to company cars (Amsterdam Roundtable Foundation, McKinsey & Company,

2014). Apart from initial cost, the government provides incentives to reduce the lifetime cost and provide convenience in order to motivate more drivers to be an early adopter of EV.

The Oslo government also subsidizes the EV drivers by providing usage incentives, such as free toll fees, reduction in annual circulation tax, financial support for charging stations, and increase coverage of fast charging stations (Petter Haugneland, Hans Håvard Kvisle, 2015). It is estimated that EV drivers in Oslo save toll road charges, parking fees in the city centre of Oslo, road use charges and VAT on fuel annually at EUR 1,313, EUR 4,691 and EUR 375 respectively (Bjart Holtsmark, Anders Skonhoft, 2014). EUR 1,200 is provided as subsidize to individuals by Oslo government if they install an EV charging station (Amsterdam Roundtable Foundation, McKinsey & Company, 2014).

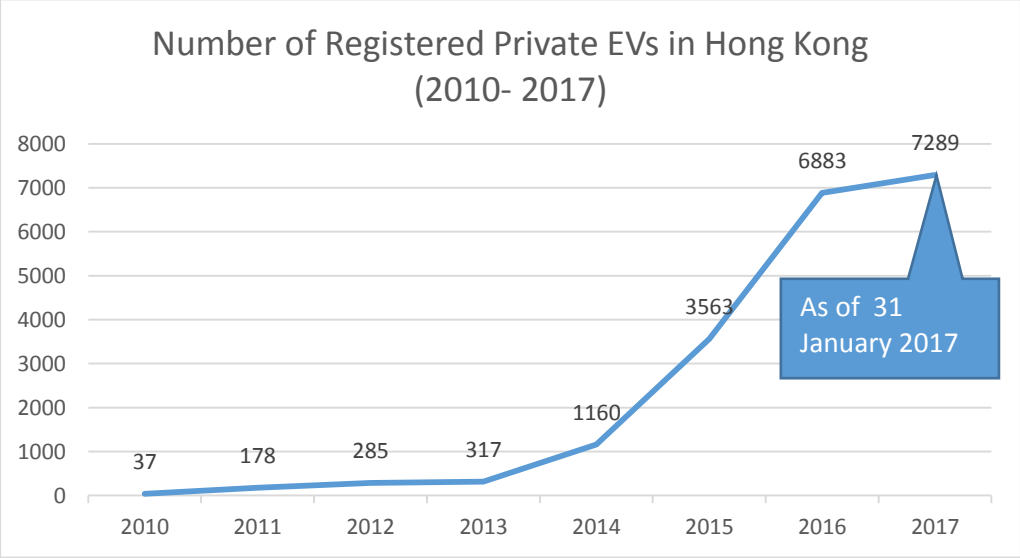
Oslo provides a range of driving privileges for EV drivers in order to attract early adopters. EV drivers are allowed to access the bus and taxi lanes, free parking and charging in the city centre. The ability to access to bus lanes allows EV drivers in Oslo save time significantly during rush hours (Amsterdam Roundtable Foundation, McKinsey & Company, 2014).

3. Background of the Case Study

3.1. Overview of EVs in Hong Kong

By January 2017 (Transport Department, 2017), there were a total of 812,645 registered vehicles in Hong Kong (Table 3). There were 7,289 registered EVs, which account for 0.00897% to the total number of registered vehicles. 7,025 of them were private cars, accounting for 0.0120% of the total number of registered private cars. Compare to 138 registered EVs with 37 were private cars in Hong Kong in the end of 2010 (Transport Department, 2010), there was an increase of 51.8% in total number of registered EVs and 188.9% in total number of registered electric private cars (Figure 2). The large proportion of private cars indicating its strategic role in the diffusion of EVs in Hong Kong.

Figure 2: Number of Registered Private EVs in Hong Kong (2010-2017)



Source: Author, Data: Transport Department, 2017

There is a rise in number of EV providers and models available in the previous decades. There were 3 EVs providers which provide one EV model each in 2010, and rise to 16 EV providers with 66 models covering private cars, motorcars, commercial and public transports in 2017 (Environmental Protection Department, 2017). In 2017, most of the EVs are selling at a net price of around HK $300 thousand to HK $500 thousand. Tesla, the largest EV provider in Hong Kong, sells its vehicles at a higher net price ranged from HK $570 thousands to over HK $1million.

Table 3: Summary of EV statistics in Hong Kong in 2010 and 2017

	2010	2017	Percentage change between 2010 and 2017
Amount of all types of vehicles			
Total number of registered vehicles	649,105	812,645	+25%
Registered EVs	138	7289	+5,181%
Registered EVs to Total number of registered vehicles	0.00021%	0.00897%	-
Amount of private cars			
Registered private cars	442,024	583,997	+32%
Registered electric private cars	37	7025	+18,886%
Registered electric private cars to Registered private cars	0.0000837%	0.0120%	-
Market share of private cars	68%	72%	-
EV providers and models available			
Amount of EV providers	3	16	-
EV models available	3	66	-

Source: Author, Data: Transport Department,2017,2010

From the above, there are strong evidences showing Hong Kong is still at the niche stage of EVs adoption, especially electric private vehicles. Hong Kong is still a niche market although there is a growth in total number of registered EVs, especially for electric private cars. It falls much behind the definition of initial stage of deployment of EVs, which defined as the 2 to 3% of consumers using EVs in the entire vehicle market (Rogers, 1962). Private car has a strategic role in increasing the market share of EVs by its extraordinary large percentage in the total number of vehicles in Hong Kong.

3.2. Incentives of EV in Hong Kong

3.2.1. Governmental incentives

From 1994, the Hong Kong government fully waived the First Registration Tax (FRT) for EVs, which the rate of tax increase progressively with the retail price of the vehicle (Appendix 1). Take the basic model of Tesla Model S60 as an example, HK $356 thousand of tax can be exempted for its retail price at HK $570 thousand. It is the first EV-related measures implemented in Hong Kong market (Central Policy Unit, 2015). In The 2017-18 Budget (Chan, 2017), although the full FRT waiver for non-private EVs is extended to March 2018, the FRT for electric private cars waiver is capped at HK$97,500 starting from April 2017.

Apart from the FRT, EVs in Hong Kong enjoy a cheaper licence fee than internal combustion engine vehicles (ICEVs). The Transport Department charges the annual fee for vehicle licence of every EV with less than 1 tonnes for HK$440, and additional fee for each 250kg unlanden weight for HK$95 (Transport Department, 2005). However, ICEVs are charged according to their cylinder capacity and fuel type, which increase with the cylinder capacity (Appendix 2).

The government established the Steering Committee on the Promotion of Electric Vehicles in 2009 for collecting opinions from experts to promote EVs in Hong Kong. In 2010, the government set the policy objective of using zero-emission buses across the entire Hong Kong territory and started providing subsidies for franchised bus companies and further exemption on the tax for environmental friendly vehicles (Legislative Council, 2016). In 2014, the government set up the Pilot Green Transport Fund to encourage the innovation on green transport technologies (Central Policy Unit, 2015).

The Hong Kong government not only provides direct fiscal support to EVs development, but also incentives in other aspects. In 2011, the government exempts the Gross Floor Area for the parking space featured with charging facilities for EVs in the developing proposals of the developers (Central Policy Unit, 2015). In the same year, the Hong Kong Planning Standard and Guidelines was updated with a suggestion of providing charging facilities for EVs in 30% of private car parking space in residential, commercial and industrial car parks. Moreover, EVs are exempted from the Motor Vehicle

Idling (Fixed Penalty) Bill (Environmental Protection Department, 2011).

3.2.2. Market-led Pilots and Initiatives

The market incentives mainly come from the two electric companies and Tesla. The two electric companies in Hong Kong, CLP Power Hong Kong Limited (CLP Power) and Hong Kong Electric Limited(HKE), started to provide a range of EVs stimulating programs for the public in 2010, for example, EV leasing schemes, parade and exhibition, and test driving (Hong Kong Electric Investment, 2010) (CLP Power Hong Kong Limited , 2011). Both companies provide free EVs charging services in government and public car parks until the end of 2017 (HK Electric Investments, 2016) (CLP Power Hong Kong Limited, 2016). By late 2016, HKE has introduced 6 standard charging stations and 4 fast charging stations on Hong Kong Island, while CLP Power has constructed 45 charging stations with 145 charging points in Kowloon, the New Territories and Lantau Island (Environmental Protection Department, 2017).

Tesla, the largest EV supplier in Hong Kong, provides fiscal incentives for their potential EV consumers, the "Tesla Value Loan Program", and "Resale Value Guarantee" (Tesla Motors HK Limited, 2014). Tesla also provides maintenance plans for their consumers which cost according to travelling distance.

3.3. The Development of EV Charging Infrastructures in Hong Kong

Charging infrastructure is particular important for EV drivers. It provides the electricity for daily operation of an EV. There are public and private chargers. In Hong Kong, there are a total of 1532 public charging stations (Environmental Protection Department, 2017) (Tesla, 2017). CLP and HKE, the two electricity companies in Hong Kong are the major public charger providers.

The chargers are categorized according to their charging speed, which are standard, medium, and fast (Table 4). Their charging speed greatly varies in recharging time (Table 5). They are distributed in Hong Kong Island, Kowloon and the New Territories in a similar proportion. Most of the fast and medium charging stations are located in the New Territories and Kowloon, while 68 of them are Tesla Superchargers which mainly located at Kowloon and Hong

Kong Island (Map 1) (Environmental Protection Department, 2017) (Tesla, 2017)

Table 4: Types of Charging Stations in Hong Kong

	Hong Kong Island	Kowloon	The New Territories	Total
Amount of charging stations	536	515	481	1532
Types of charging stations				
Standard (Figure 3)	361	314	279	954
Medium (Figure 4)	113	124	108	345
Fast (Figure 5)	62	77	94	233

Source: Author

Table 5: Charging Speed of 3 Types of Chargers

	Standard	Medium	Fast
Time required to fully recharged EV with a battery capacity of 24kWh	8 – 10 hours, may up to 30 hours if using 13A standard socket	2 - 5 hours	Less than 1 hour

Source: Author, Data: (CLP Power Hong Kong Limited, 2015).

Map 1: Location of Public Chargers in Hong Kong

Source: Author,

Figure 3: Standard Charger

Data: (Environmental

artment, 2017) (Tesla, 2017)

Source: Author

Figure 4: Medium Charger

Figure 5: Fast Charger

Source: Author

Private charging services are mainly provided by Smart Charge and Hong

Kong EV Power Limited (EV Power), which are the two major charging companies in Hong Kong focusing their business on home charging. They take up the entire cost for the construction of charging infrastructures at their own capital and cost the user in a basis of time. These charging stations mainly locate at residential buildings, including garage of villas and car parks of apartments.

Map 2 shows the location of 22 private chargers installed by EV Power and 2 private chargers installed by Smart Charge in residential buildings. Table 7 shows the incentives provided by the major public and private chargers providers in Hong Kong and the service providers for better understanding.

Map 2: Location of Private Chargers in Hong Kong

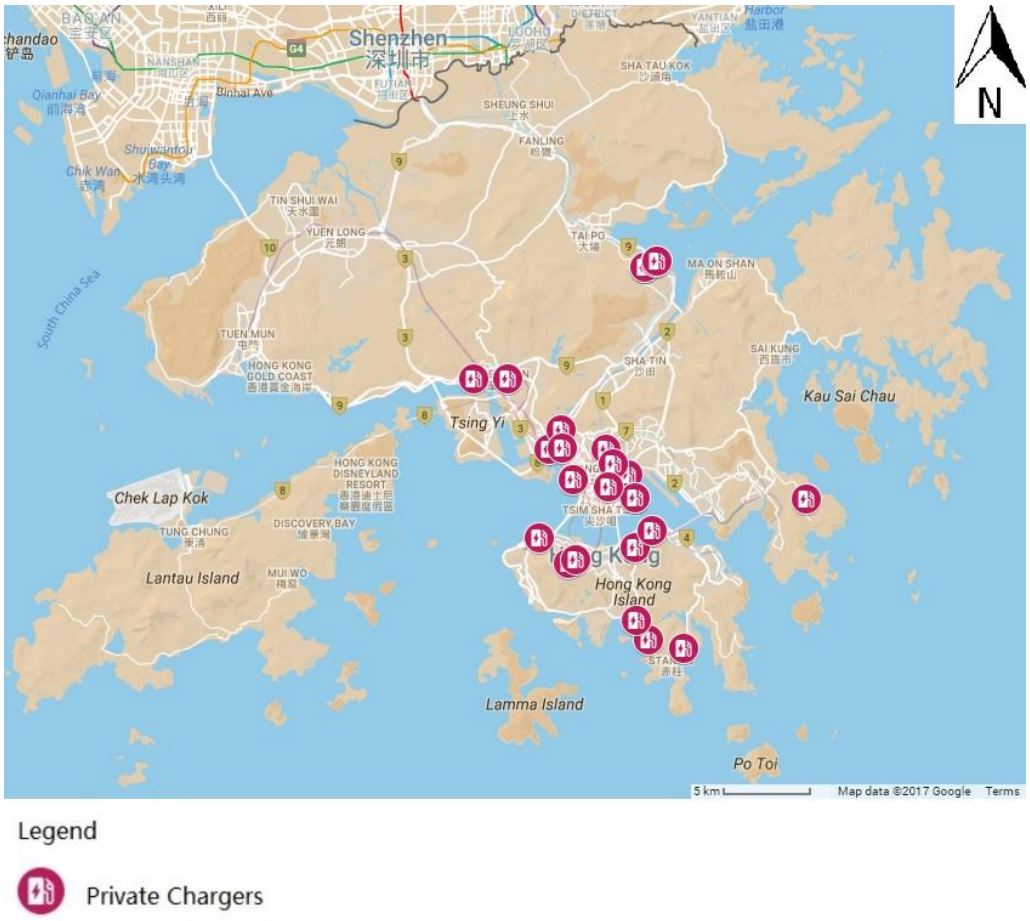


Table 6: Charging Service Model of Smart Charge

	Subscription Model	Buy and Own Model	Park and Charge Model
Service area	Home charging (Apartment)	Home charging (Villa)	Public charging
Type of chargers	Medium	Medium	Fast or Medium
Payment basis	Monthly	Monthly	Hourly

Source: Author

Source: Author,

Map Data: Google,

Data: (Hong Kong EV Power Limited, 2016) (Smart Charge, 2016)

Table 7: Major Public and Private Charging Service Providers and Incentives Provided

	Major public charging service providers			Major private charging service providers	
Service provider	CLP Power Hong Kong Limited (CLP)	The Hongkong Electric Company Limited (HKE)	Tesla	Smart Charge (HK) Limited (Smart Charge)	Hong Kong EV Power Limited (EV Power)
Company nature	Power company	Power company	EV distributor	Joint venture of CLP and Hong Kong Telecommunications Limited (HKT)	Young green energy company
Year of first provide service	Late 2009	Early 2010	2010	2016	2010
Incentives provided	Detail tailor-made EV chargers installation consultation for interested consumers including EV drivers, Owners' Corporation (OC), and Building Management Office (BMO)				
	Test driving week, EV leasing programs		Free fast charging for Tesla drivers[2]	Provides both public and private charging services to their customers depends on the charging model (Table 6)	Residential Apartment Scheme provides tailor-made chargers installation services for housing estates
		"HK Electric Low Carbon App" for EV drivers to access to information about the HKE charging stations and book the fast charging station	Drivers can locate the nearest Supercharger through the build-in touchscreen installed in the EV		E-Charge provides an online platform for payment and receive information about EVs and locations of charging stations all over Hong Kong for the users
			Gifts a Wall Connector for every customer, which can be installed as a standard or medium charger at home		

Source: Author, Data: (Hongkong Electric Company Limited, 2010)(CLP Power Hong Kong Limited, 2016) (Leung, 2016) (Telsa Guide HK, 2017) (HKT Limited, CLP Holdings Limited, 2016) (EV Power Group, 2016)

[2]Starting from January 2017, Superchargers cost HK$1.5 to HK$3 per minute depends on the charging speed after a free charging quota of 400kWh every year.

4. Literature Review

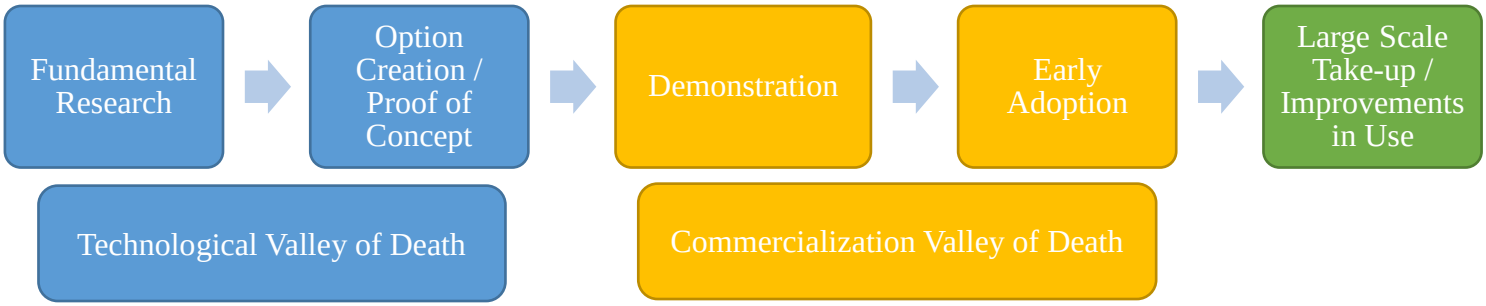
4.1. EVs and Sustainability

The concern on the environmental impact of road transport system is increasing in recent years (Robert L. Hirsch, Roger Bezdek, Robert Wendling, 2005). The interest in sustainable transportation is rising and electric vehicles (EVs) are considered to cope with the challenges (Thomas Franke, Franziska Bühler, Peter Cocron , Isabel Neumann, Josef F. Krems). EVs, which have a higher sustainability, have a higher efficiency (85 to 95%) and zero tailpipe emissions when compare ICEVs which have an efficiency of 28 to 30% and emit 118 to 144g of Carbon Dioxide (CO_2) per kilometers (Ricardo Faria, Pedro Moura, Joaquim Delgado, Anibal T. de Almeida, 2012). EVs consume less energy during vehicle and battery manufacturing, operation and maintenance and repair than ICEVs (Nuri Cihat Onata, Murat Kucukvarb, Omer Tatari, 2015).

4.2. Energy Technology Innovation and Roles of Early adopters

In general, there are five stages of energy technology innovation (Figure 6): 1) Fundamental Research; 2) Option Creation/Proof of Concept; 3) Demonstration; 4) Early Adoption; 5) Large Scale Take-up/Improvements In use (Lester Richard Keith, David Hart, 2012). The first two stages are the niche research and development (R&D) of the energy technology and identify the new possibility for products (National Academies of Sciences, Engineering, and Medicine, 2016). The third stage is to obtain credible information in order to minimize technological, regulatory and business risks in applied R&D, allowing private investment in the first few commercial projects. The fourth stage is the scale up of market development and early deployment of various infrastructures, while the fifth stage is having a stable and predictable regulatory and market environments.

Figure 6: Stages of the Innovation Process and Valleys of Death



Source: (Lester Richard Keith, David Hart, 2012)

Early adopters, the users in early adoption stage, play a key role in the learning process. They act as an important and credible information source for the potential consumers (Jonn Axsen, Kenneth S Kurani, 2012). The new energy technology is undergoing the commercialization valley of death at the stage of early adoption (National Academies of Sciences, Engineering, and Medicine, 2016). Without positive response from early adopters, it will be difficult for the energy technology to go through the commercialization valley of death, resulting in the failure of mass adoption of the technology.

4.3. Factors Influencing the Adoption of Early EV Adopters

It is essential to understand the EV drivers' behavior in order to determine the impact of EVs and to promote a sustainable and successful integration of EVs into current societies and infrastructures, as well as facilitate the development and growth of future EV market (Iana Vassileva, Javier Campillo, 2016). There are mainly three factors influencing the purchasing behavior of consumers including demographic, psychological and situational (Ben Lane, Stephen Potter, 2007).

4.3.1. Demographic Factors

The demographic characteristics, such as gender, age, and monthly income affect the intention to purchase an EV of consumers from different social levels (Iana Vassileva, Javier Campillo, 2016). Their educational level and social class influence their lifestyle and expectations towards the price environment, and further affect their purchasing behavior.

Early adopters of EVs always show similar demographic characteristics.

According to Rogers' Model for diffusion of energy technology innovation, the first 2 to 3% of the consumers who take an innovation into use, are younger men with high education, well-off with fulltime jobs and often in contact with scientific communities (Rogers, 1962). They are less worried about the low market value due to a low second hand value.

The next wave of early adopters of energy technology innovation account for 13% of total users. They are well-off, highly educated and with higher social status. They are younger than those who take the technology into use later. They are often leaders and are important for the further market penetration process through their social networks.

Studies conducted in Sweden and Germany concluded that characteristics of early EV adopters are males with medium to high income; highly educated; and high concern in environmental protection (Iana Vassileva, Javier Campillo, 2016) (Patrick Plötz, Uta Schneider, Joachim Globisch, Elisabeth Dütschke, 2014).

4.3.2. Psychological Factors

In order to achieve commercial success and lead to a sustainable market, social issues related to consumers must put into consideration apart from technological problems (Ona Egbue, Suzanna Long, 2012). Psychological factors affect the consumers' acceptance of EVs and are more related to the consumer's preferences and mindset on EV, for example, for private consumers, it is personality, attitudes, lifestyle and self-image (Ben Lane, Stephen Potter, 2007). Without consumer acceptance, the sustainable transportation sector cannot reach its success (Ritsuko Ozaki, Katerina Sevastyanova, 2011). The major influential psychological factors included attitudes towards environmental protection and lifestyle of consumer.

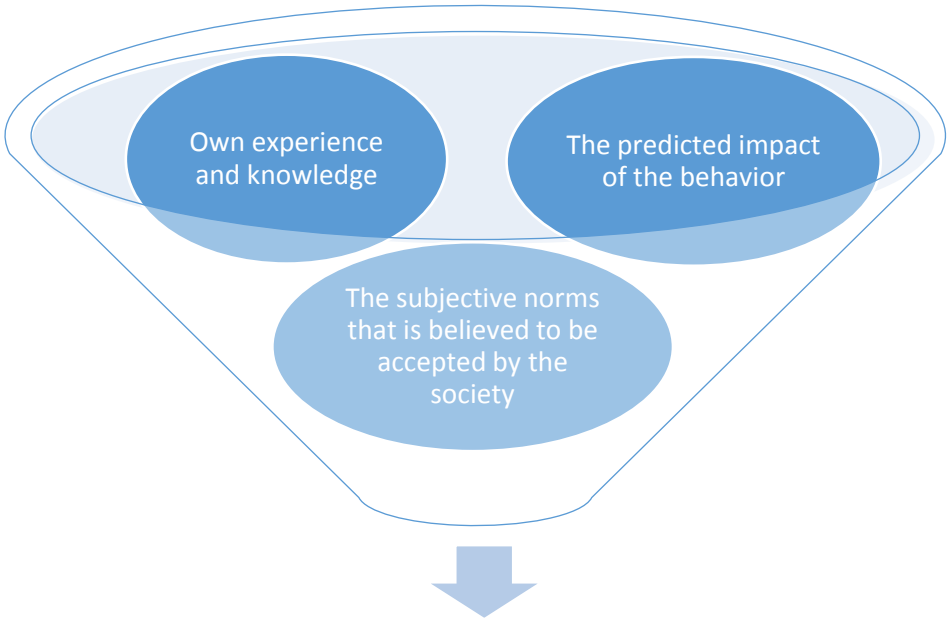
4.3.2.1. Attitudes towards Environmental Technology

Attitudes, regarded as the feeling and the mindset to a particular issues, is one of the major psychological factor affecting the consumer's behavior (Ajzen, 1991). According to the Theory of Planned Behavior by Ajzen, the consumer generates a positive attitude towards the behavior if a positive conclusion is driven after considering numerous of factors (Figure 7). Consumers with more positive attitude have a higher acceptance on the behavior. According to the theory, consumer's acceptance to a technology is considered as his intention to adopt, use, or support the development.

The consumer's perception on environmental protection and green technology also affects the level of penetration in EVs market (Alyona Zubaryeva, Christian Thiel, Enrico Barbone, Arnaud Mercier, 2012). Consumers with higher awareness in environmental protection issues and green technology issues contribute to a successful EVs market penetration.

In other words, the expansion of EV market share requires consumers with positive attitude towards EV and high awareness on environmental protection and green technology issues.

Figure 7: Factors Affecting the Attitude of Consumer



Source: Author

4.3.2.2. Lifestyle of Consumers

Lifestyle of consumers refers to the preference, routines, and habits affecting the unconscious or low conscious decision in the daily life. Habits and routines are important in determining factors of significant environmental behaviors (Stern, 2000). Habits, which is an automated behavior, takes a long time to change but once established, it will make consumers reflect less upon their behaviors.

Changing into environmental friendly habits and routines favors the purchase of EV and increase the consumer acceptance on EVs (Zeinab Rezvani, Johan Jansson, Jan Bodin, 2015) (Bakker, 2011). With the intention of going green, consumers usually shows a high interest in paying substantial premium for EV, aiming at reducing emissions from road transport (Iana Vassileva, Javier Campillo, 2016).

In a successful penetration EVs market, consumers usually have a high willingness to purchase a second car. Research conducted in Sweden and Germany suggested that the high desire to purchase a second car facilitate the EV market penetration (Iana Vassileva, Javier Campillo, 2016) (Franziska Buhler, Peter Cocron, Isabel Neumann, Thomas Franke, Josef F. Krems, 2014). Participants in the researches usually own two vehicles, whereas the EV is usually used for short trips and private use.

4.3.3. Situational Factors

Situational factors are more related to factors more related to the reality for example, economic and regulatory environment, existing road infrastructures, and vehicle performance (Ben Lane, Stephen Potter, 2007). The four major influential situational factors are: 1) Access to information; 2) Pricing of EV; 3) Performance of EV; 4) Recharging of EV.

4.3.3.1. Access to Information

Information availability to consumers directly influence their knowledge about EVs, thus affecting their purchasing preferences. When introducing new technology to a community, insufficient knowledge about the technology by the consumers is one of the major barriers for mainstreaming the technology (Diamond, 2009). With insufficient and limit access of information about EVs, consumers' willingness to purchase EVs is limited (Iana Vassileva, Javier Campillo, 2016). Non-technical sources of information including experience, emotions, and media are the major criteria for the public to build their perception of risk (Ona Egbue, Suzanna Long, 2012). Consumers with low risk tolerance are less willing to purchase an EV (Diamond, 2009).

4.3.3.2. Pricing of EV

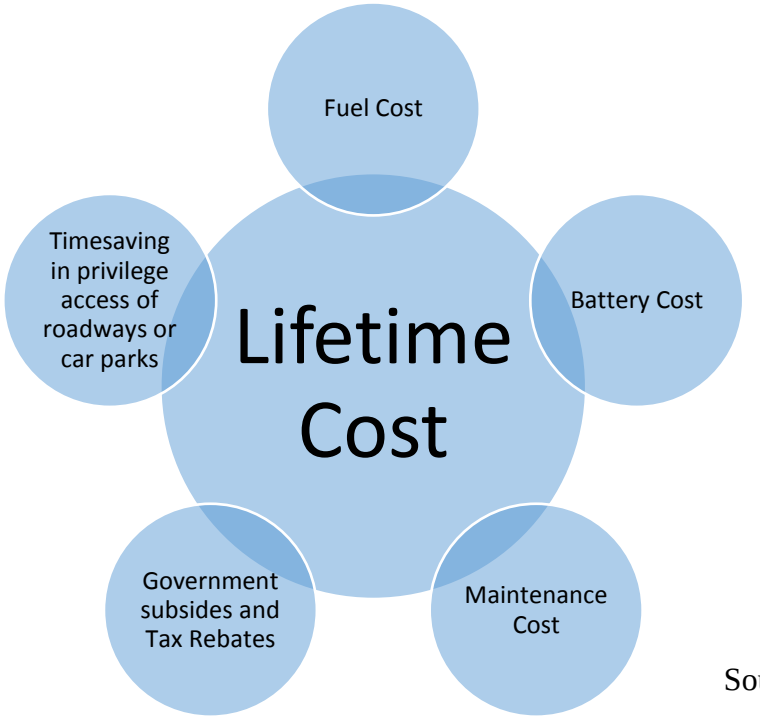
High initial cost is one of the pricing barrier to EVs (Diamond, 2009). The comparatively high price of EV to ICEVs prevent consumers from purchasing EVs (Iana Vassileva, Javier Campillo, 2016) (Bakker, 2011).

Apart from the initial cost, lifetime cost (Figure 8), which battery and maintenance cost is most concerned by experienced drivers, are other pricing factors influencing the purchase decision of consumers (Byrne, Michael Raymond; Polonsky, Michael Jay, 2001) (Zhen-Yu She, Qing Sun, Jia-Jun Ma, Bai-Chen Xie, 2017). Tax rebate is the major financial incentives for early adopters (The City of New York, 2010). Only if the lifetime expense can keep in line with ICEVs, consumers are more willing to purchase EV.

The resale value of an EV also influence the willingness of consumer to purchase an EV (Rogers, 1962). Consumers are more willing to buy vehicles with higher second hand value. EVs with a second hand value similar to ICEVs

are more attractive to consumers (The City of New York, 2010).

Figure 8: Lifetime Cost Affecting Purchase Decision of Consumers



Source: Author

4.3.3.3. Performance of EV

Performance of EV is a major influential area in consumer acceptance (Bakker, 2011). Battery is the core part of an EV, which is a key issue to be overcame in order to increase its capacity and power with reduction in price (Ritsuko Ozaki, Katerina Sevastyanova, 2011). The level of advancement of battery technology induce other concerns. Range anxiety, means the anxiety induced by the limited driving range of the battery-powered engines versus the range offered by internal combustion engines (Iana Vassileva, Javier Campillo, 2016). Only if the battery is powerful enough with high capacity, which can sustain a distance of driving without recharging during the journey, the range anxiety of drivers can be alleviated.

Apart from battery technology, other aspects such as power, acceleration, and availability of maintenance service also influence the purchase decision of consumers (Gordon Ewing, Emine Sarigollu, 2000). Insufficient aftersales maintenance and repair services inhabit the purchase desire of consumers (Byrne, Michael Raymond; Polonsky, Michael Jay, 2001).

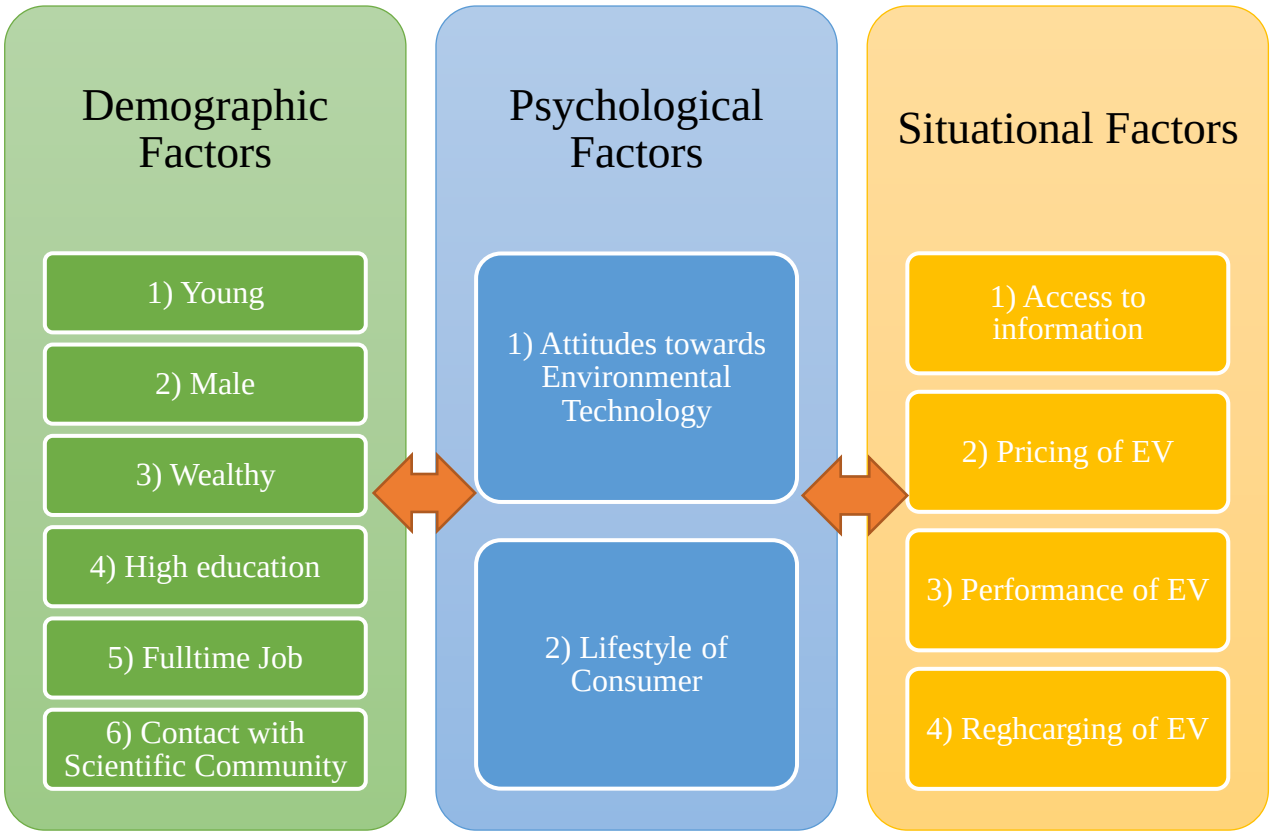
4.3.3.4. Recharging of EV

Recharging of EV is another major concerns for EV drivers, as the related issues create range of anxiety. Availability of refueling stations and time for refueling affects the willingness to purchase of consumers. Compare to the ICEVs which refueled by easily accessible fossil fuel stations, limit access of charging infrastructure and long recharging time of EVs generate range anxiety, and hinder the mass adoption of EVs (Iana Vassileva, Javier Campillo, 2016) (Electrification Coalition, 2009). A study in New York pointed out that in the early stage of EVs adoption, consumers desire a strong guarantee on the availability of charging equipment to avoid running out of battery of the EV which is an unacceptable consequence (The City of New York, 2010).

The availability of public charging infrastructure is especially important and is one of the major influential areas in EVs adoption (Bakker, 2011). Public charging is essential and particularly important to EV drivers who do not own a home-charger and depends on street charging (Electrification Coalition, 2009).

In short, there are three major influential and interrelated factors on purchasing behavior of early adopters: 1) Demographic; 2) Psychological; 3) Situational. They are factors from different aspects, but interrelated with each other. Figure 9 shows a concept figure showing the list of factors and their relationship.

Figure 9: An integrated Framework of Factors Influencing Purchase Decisions of Consumers



Source: Author

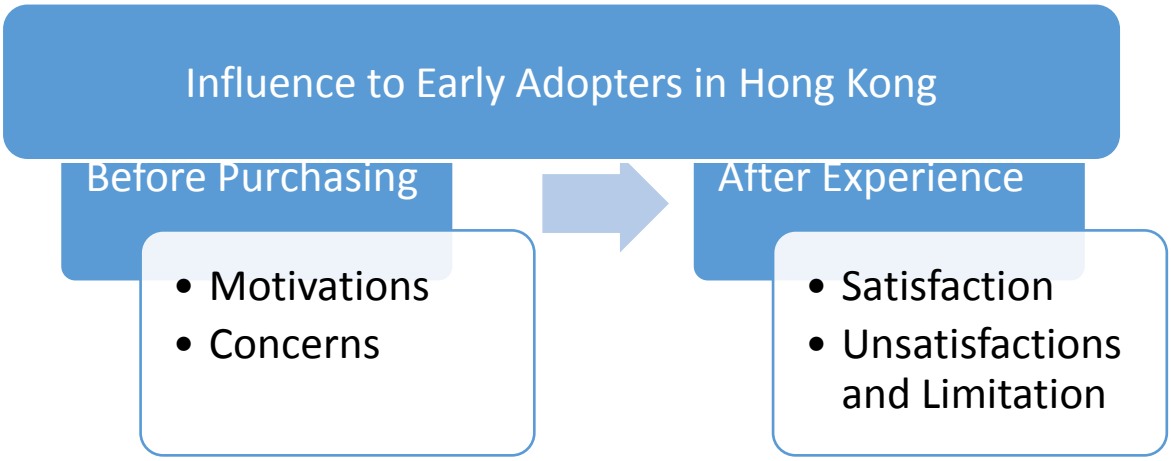
4.4. Knowledge Gaps

From the above, it is clear that a range of motivations and concerns influence the purchase decision of early adopters on EVs. The experience of the EV early adopters is important as it greatly affects the ability of the energy technology to pass through the commercialization valley of death. Without high satisfaction of experience, there will not be a continuous and growing adoption in EVs. Only if EVs reach the stage of large scale take-up, it can be a sustainable business to support mass market adoption.

The motivations and concerns before purchase, and the satisfaction after experience of early adopters influence much to the penetration of EVs in market. With strong motivations and less concerns, drivers are more willing to become early adopters. This create a niche market for EVs and a possibility for future growth. After experiencing, a high satisfaction level on EVs motivates the early adopters continues to use vehicles, becoming majority adopters. With mass adoption in the market, EVs can be a sustainable business and dominate the market share.

This paper is, to mainstream EVs in Hong Kong, focus on identifying the motivations and concerns among early adopters in Hong Kong, and their satisfaction on their experience on EVs (Figure 10). The limitation of the business environment is going to be examined in order to provide policy recommendation for further mainstreaming EVs in Hong Kong.

Figure 10: Research Focus of this Study



Source: Aut

5. Methods

In this paper, three research methodologies were used: 1) Desktop Research; 2) Site Visit; 3) Face-to-Face Interview. Qualitative field research with in-depth and semi-structured interviews were conducted in this study. Qualitative research is recognized to be a social research tool to gain in-depth knowledge and understanding on a particular issue (Jeff Sommerfeld, Laurie Buys, Desley Vine, 2017). Interview is one of the most commonly used social science research method which allow researchers to engage in a conversation with the participants. Interviewers are able to explore the subjective opinion of the participants about usefulness and barriers to use a technology (Connelly K, ur Rehman Laghari K, Mokhtari M, Falk T.H., 2014). Ethical approval for this research has been applied and approved in order to invite participants to attend the interviews.

The research questions for the study is set to be: 1) What are the motivations and concerns for early adopters in Hong Kong to purchase EVs?; 2) Are they satisfied with their EVs after experiencing?; 3) In what ways that government policies in Hong Kong could be improve in order to increase satisfaction of early EVs adopters and scale up the adoption of EVs?

5.1. Desktop Research

A range of reports and papers published by various companies and organizations were used for analysis in this research. List of private and public chargers' location were collected from Environmental Protection Department (EPD) of HKSAR, Tesla and charging companies. It is used for selecting locations for site visit and locations to invite early adopters for face-to-face interviews.

Publications from Tesla and charging companies, such as press release, reports and presentations for drivers, were the major source of understanding the current market development. The information disclosed by their official websites was the source to access the most updated market situation.

Governmental publications of Hong Kong were the source to understand the policies and measures for EVs. Information from EPD provided an overview of EVs development in Hong Kong. The Budget was used to examine the present and future EV policies, while publications from the Central Policy Unit and

press release was used to examine the past EV policies. Lists of data released by the Transport Department were used to analyze the cost of EVs.

5.2. Site Visit

Star Ferry Pier Car Park, Yoho Mall II, a village house in Yuen Long and Hong Kong Science Park were selected to conduct site visits based on the list collected from desktop research (Map 3).

Star Ferry Pier Car Park is located at Central, the Central Business District in Hong Kong. It can be easily accessed from the commercial and business centre in Hong Kong Island and Kowloon. Yoho Mall II is located at Yuen Long, the centrum of Western New Territories. Hong Kong Science Park is located at Tolo Highway, which is the major highway linking the Southern and Northern New Territories as it connects to Fanling Highway and Shatin. Shatin can be connected with Kowloon by Lion Rock Tunnel, allowing Hong Kong Science Park to be easily reached from Northern New territories to Kowloon.

A village house in Yuen Long was visited to investigate the experience of home charging. Its location is not indicated in Map 3 due to privacy.

Map 3: Location of Site Visits

Source: Author, Map Data: Google

5.3. Face-to-Face Interviews

5.3.1. Early Adopters

15 early EVs adopters were invited for a face-to-face interview in this research. Conducting face-to-face interviews with early EVs adopters enable the collection of firsthand information about their motivations and concerns before purchase, and satisfaction after experiencing EVs.

The interviews of the early adopters were conducted in the afternoon of 3 weekends of March 2017 (4/3, 11/3, 18/3). 15 EV drivers were randomly invited during the site visits (Table 8). Most of them were interviewed on roadside and in public car parks, such as Star Ferry Car Park, Yoho Mall II, and Hong Kong Science Park. Most of the interviewees at Hong Kong Science Park were charging or waiting for Superchargers, while those at the rest of the locations were waiting on roadside or preparing to leave the car park.

The interviews included three themes of questions: 1) Demographic and basic information of interviewees; 2) Their perceived motivations and barriers; 3) Their satisfaction on EV experience. List of sample questions can be found in Appendix 3. In the first part, basic demographic information of the participants was collected, including their age, gender, education level, occupation, and monthly income.

Table 8: Location of interviews

Interviewee	Location	Interviewee	Location
1	Star Ferry Pier Car Park	9	Hong Kong Science Park
2	Star Ferry Pier Car Park	10	Hong Kong Science Park
3	Star Ferry Pier Car Park	11	Hong Kong Science Park
4	Village house in Yuen Long	12	Hong Kong Science Park
5	Yoho Mall II	13	Hong Kong Science Park
6	Hong Kong Science Park	14	Hong Kong Science Park
7	Hong Kong Science Park	15	Hong Kong Science Park
8	Hong Kong Science Park		

Source: Author

In the second part, questions about the motivations and barriers for early adopters has been asked, for example, 1) What motivates and in what extent does it influence your purchase desire of EV?; 2) How do you access to information about EVs?; 3) What do you think is the most inhibiting factor to your purchase?. Their attitude towards environmental protection has been examined by asking questions, for example, are you willing to spend more on energy-saving products?.

In the third part, questions about satisfaction of early adopters on EV experience has been asked, for example, 1) Do you satisfy with the performance, aftersales services, and maintenance and repair series of your EV?; 2)Do you satisfy with the location and amount in chargers in Hong Kong?

5.3.2. Informants

2 knowledgeable informants in the EV industry in Hong Kong have been invited for a face-to-face interview last for around 45 minutes on weekdays in March 2017. They are a scholar and a senior executive of an EV charging company. They both have expert understanding about governmental and corporate attitudes and concerns about EVs, which is difficult to access by general public. Interviewing them can obtain more in-depth information for critical analysis.

A scholar was invited as an informant for face-to-face interview. EV study was his expertise. He was the former member of the Steering Committee on the Promotion of Electric Vehicles under the Environmental Protection Department of Hong Kong Government. In the interview, questions about EV development in Hong Kong and governmental policies were asked. Sample questions are attached in Appendix 5. The questions covered the following themes: 1) The current situation of EV deployment in Hong Kong; 2) Major barriers to the EV deployment in Hong Kong; 3) Prospect of future mainstreaming EVs in Hong Kong.

A senior executive of an EV charging company with engineering background was invited as an informant for face-to-face interview. The interview was focusing on: 1) The business model of the company; 2) The company's motivations and challenges when moving in such a new industry as an incumbent in the electric industry; 3) The deployment of the charging industry

in Hong Kong and brief introduction on the company's future strategies. Sample questions can be found in Appendix 6.

6. Key Findings and Discussions

6.1. Cost is the Primary Concern

The initial cost of the EV is obviously the controlling factor on the purchase decision of early adopters as indicating by the interviewees and informants. 16 out of 17 of them indicated cost is the primary concern on their purchase. Table 9 list out all the motivating factors for the interviewees. The full-waive in FRT is the greatest motivation to early adopters in the interviews as it greatly reduces the initial cost of EVs to an acceptable price range.

Table 9: Motivating Factors for Interviewees

Interviewees	1	2	3	4	5	6	7	8
Motivating factors	$ G	$ G	$ G	$ G P T	$ T C	$ G	$	$
Interviewees	9	10	11	12	13	14	15	
Motivating factors	$ C G	$ T	G T	$ T	$ G	$ G	$ G Pe	
Legend: $: Cost including reduction in fuel cost, initial cost G : To go green P : Privileges T : New Technology C : Easy to find chargers / Available for home charging Pe: Performance								

Source: Author

Most of the early adopters vigorously against the capping of FRT waiver and indicated that they would not consider purchasing an EV if the cap applied at the time they purchased. Without full FRT waiver, the initial cost of EV was unaffordable to them which is almost doubled. The dramatic increase in initial cost of EVs inhibit the desire to purchase of drivers. The scholar commented it as an unfortunate signal on the road to promote EVs as it is the most powerful short-term instrument to reduce the cost of EVs. He indicated that although battery account for the highest cost in the production, the cost of EVs is expected to reduce to similar range with ICEVs in 2020 as battery technology improves. Before that, FRT is the major and only method to reduce cost for EV

as short-term instruments.
However, Hong Kong is facing more on institutional barriers. The scholar indicated that the former Financial Secretary was more committed to EVs promotion than the present one and the Transport Department shows low commitment to the promotion. These institutional barriers inhibit the governmental support and incentives for EVs, with the current policy of capping in FRT waiver as the best evident.

Compare to the initial cost, lifetime cost is less concerned by the early adopters, but is still important in influencing the desire of purchase. Fuel for EVs is considered to be free as it is free to charge at public chargers. Some early adopters indicated that there is an 80% reduction in fuel cost when compare between his EV and ICEV with same usage.

Although some public chargers are located in paid carparks, it does not make a big difference to early adopters since parking is also necessary for ICEVs. The "Resale Value Guarantee" offered by Tesla alleviate their concerns on second hand value of EVs, which make it no longer a major influential factor to the purchase decision of early adopters.

6.2. Situational Factors Are More Influential than the Other Factors

The situational factors are more influential than psychological and demographic factors on EV purchase decision among early adopters in Hong Kong (Table 10). After experiencing EVs, early adopters are satisfied with the accessibility of information, pricing, performance, and recharging of the EVs. However, they indicated that pricing level of EV is too high to buy if FRT is capped.

The interviewees are usually middle-aged male with high education, fulltime job, and wealthy (Appendix 3), however, with a certain number of interviewees with lower education and income. Early adopters with higher education and fulltime job are usually wealthier than those with lower education and without fulltime job. With a high education background, early adopters have a higher acceptance and eager to try new technology which enhance their interest in purchasing an EV.

Table 10: Factors Influencing the Purchase Desire of Interviewees

Interviewees	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Situational factors															
Pricing of EV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓
Access to information	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	×	✓	✓	✓	✓
Recharging of EV	✓	×	×	×	✓	×	×	×	✓	×	×	×	×	×	×
Performance of EV	×	×	×	×	×	×	×	×	×	×	×	✓	×	×	✓
Psychological factors															
Attitude towards environmental technology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lifestyle of consumer	×	✓	✓	✓	✓	×	×	×	✓	✓	✓	×	✓	✓	×

Legend:

✓ : Purchase desire of interviewees was influenced by the factor

× : Purchase desire of interviewees was not influenced by the factor

Source: Author

Middle-aged people usually worked in the society for a longer time than the youth, allowing them to develop a better financial base. Early adopters of middle-aged male, high education, fulltime job indicating they are usually wealthier and more interested in EVs, thus have a higher purchasing power and willing to purchase EV. This phenomenon indicated the demographic factors are not very influential on the purchase decision of early adopter.

In the interviews, all of the interviewees indicated that "EV is a green technology" is one of the reason for their purchase. However, they emphasized that their final decision of purchase depends on the price of the EV.

Lifestyle of the interviewees is not found to be a critical influential factor for their purchase. Although 14 interviewees showed a sense of going green and willing to spend more on energy-saving products, they emphasize the pricing of the product strongly influence their final decision of purchase. Such phenomenon indicates that pricing is the most influential factors among the early adopters, which overtakes the importance of psychological and demographic factors. 66% of the interviewees have their EV as the second or third car, indicating ICEVs as the major transport vehicle still cannot be overtook by EV.

Apart from pricing, as discussed in the last section, the access to information influence much to the purchase decision of the interviewees when compared to the performance and recharging of EV. 13 interviewees indicated that the availability of information influence on their purchase decision of EV. However, the performance and recharging of EV does not influence the purchase decision of the interviewees much.

Form the above, it can be seen that demographic and psychological factors influence the purchase decision of the early adopters in some extent, situational factors, especially pricing, are the critical factors to their final decision of purchase.

6.3. Managerial and Institutional Barriers on Charging Infrastructures

Apart from the three factors influencing the purchase desire of early adopters in Hong Kong, institutional barriers are found to threaten the penetration of EVs in Hong Kong market. Below summarized the three major institutional barriers discovered in this research.

6.3.1. Mismatch of Chargers Types Available and Needs of Early Adopters

Although the interviewees blamed the insufficient of chargers is the reason for the long waiting time for fast chargers, it can be deduced that the problem is the number of fast chargers but not the total number of chargers by looking at the empirical data from site visits and documents.

Most of the interviewees indicated that they usually charged with fast or medium public chargers, especially Tesla Superchargers. However, only 15.21% and 22.52% of the 1523 public charging stations in Hong Kong are fast and medium chargers respectively while Tesla Superchargers only account for 4.44% (Table 11Table 11), which the total number are much less than standard chargers. The statistics shows a mismatch of existing chargers types to the needs of early adopters.

Table 11: Statistics on Public Chargers in Hong Kong

	Amount of Chargers	Percentage to Total Number
Standard Chargers	951	62%
Medium Chargers	345	22.5%
Fast Chargers	233	15.2%
(Tesla Superchargers)	68	4.44%
Total number	1532	100%

Source: Author, Data: (Environmental Protection Department, 2017)

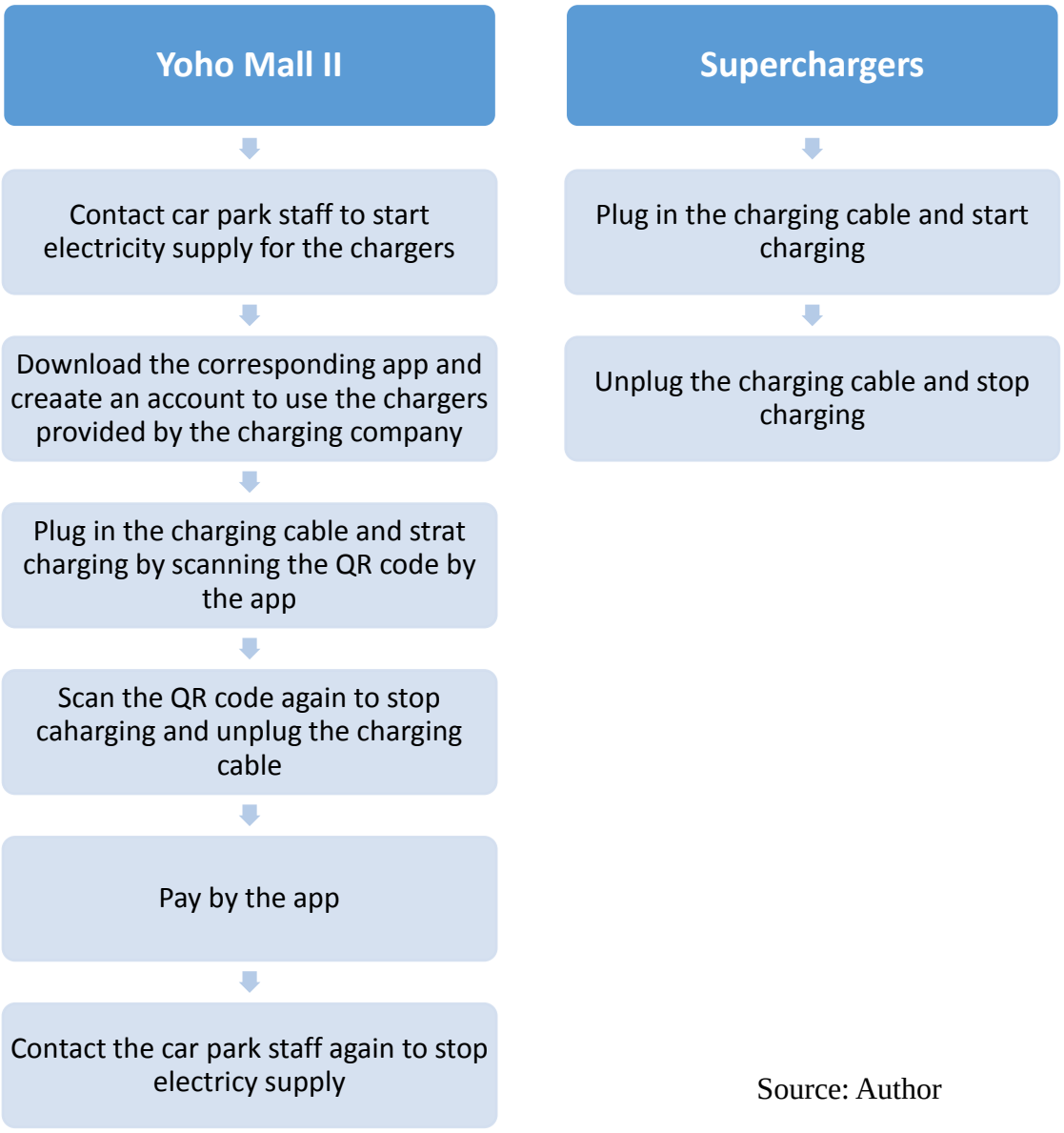
The mismatch of chargers leads to low utilization rate. Early adopters rely much on fast and medium chargers, while standard chargers are not used in a frequency as designed. It can be concluded that the concerns from experienced early adopters do not come from the problem of insufficient of chargers, but is insufficient of fast and medium chargers which meet the needs of early adopters.

6.3.2. Complicated Procedures to Use Public Chargers

The complicated and diverse procedures to use public chargers is another management failure in charging infrastructures, which causes the EVs flooded to Tesla Supercharger, which there are only 68 in Hong Kong, for charging. To use the chargers in governmental public car park and shopping malls, drivers need to contact with the car park staff by phone in order to start electricity supply for the chargers. As there a numerous of charging companies providing public charging services, drivers need to download corresponding app and create an account or join as a member in order to use the charging services provided by particular company.

Figure 11 shows the difference in procedures when using the public chargers in the shopping mall, Yoho Mall II as an example (Figure 12, Figure 13), and Superchargers. The procedures to use chargers in shopping malls is much more complicated and time consuming than Superchargers. This cause extreme inconvenient to drivers when charged at different location.

Figure 11: Difference in Procedures when Using Public Chargers in Shopping Mall and Superchargers



Source: Author

Figure 12: Signs to Inform EV Drivers to Contact with Staff for Charging Services at Yoho Mall II

Source: Author

Figure 13: EV Charger and Control Terminal at Yoho Mall II

Source: Author

6.3.3. Poor Management on Charging Infrastructures

From the site visits and reflection from interviewees, the poor management on charging infrastructures intensified the shortage problem of fast and medium chargers. There were some misbehaved ICEVs and EVs occupying the charging space, however, with limit penalty or regulation to restrict their behavior (Table 12). The misbehavior violates the rights to use of other EV drivers. It also reduces the utilization rate of chargers, which lengthened the payback period of the charging and threaten the business revenue and inhibit the development of the charging company.

Table 12: Sample Misbehavior and Corresponding Management Action of ICEVs and EVs

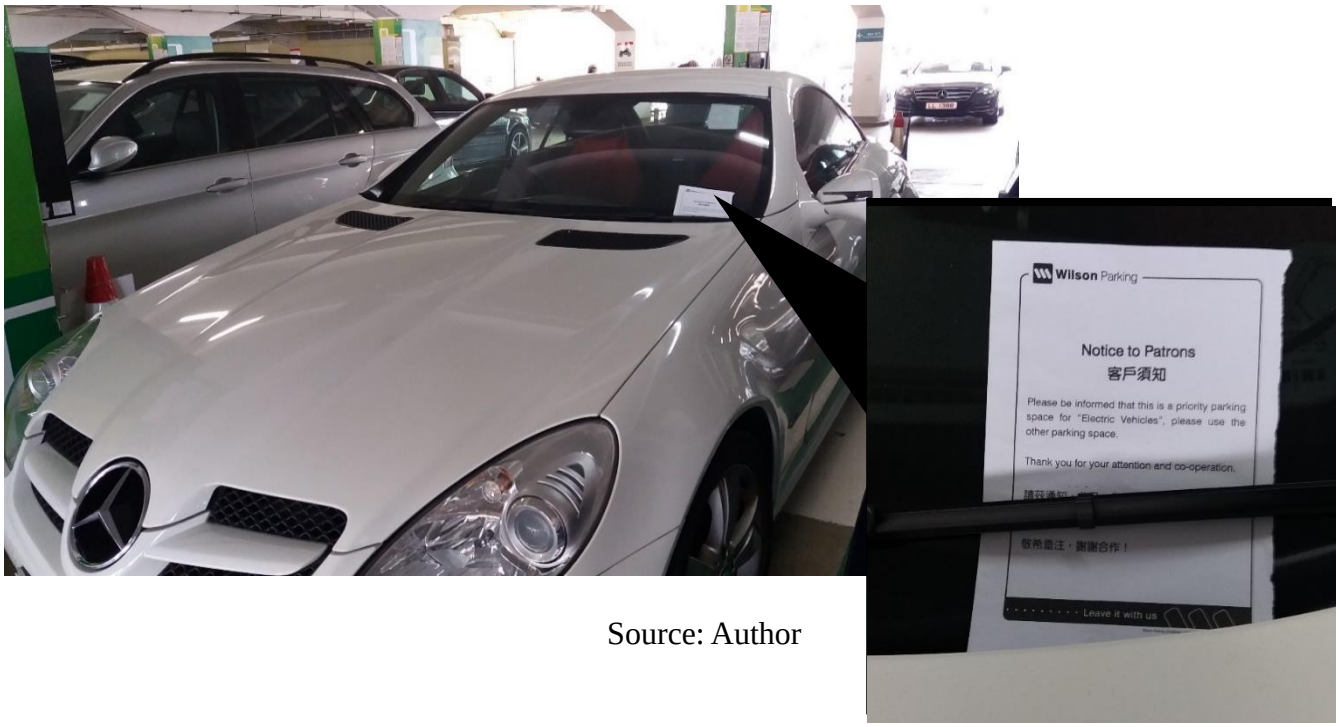
	Misbehavior	Corresponding management action
ICEVs	• Parking at charging station	• Placing notice on the vehicle and the charging station
EVs	• Occupying the charging station after fully recharged	• No obvious action

Source: Author

Figure 14: Sign for Indicating Priority Use for EVs in Star Ferry Pier Car Park

Source: Author

Figure 15: Notice to Patrons on an ICEV Parking at EV Charging Space in Star Ferry Pier Car Park



Source: Author

Star Ferry Pier Car Park showed a range of misbehavior of ICEVs and EVs and management problem at the time of site visit. There were 1 fast charger, 8 medium chargers and 37 standard chargers. No standard chargers were in use and were all occupied by ICEVs for parking. Fast and medium chargers were mostly occupied with no lines waiting. Some EVs were found parking at space without chargers but some ICEVs were parked at medium charging stations. Signs indicating the priority use for EVs were placed at the medium chargers (Figure 14). Notice to Patrons were put on the misbehaved ICEVs to inform the drivers about the special use of the space (Figure 15). However, no other punishment action, such as fined or towed, were observed.

6.3.4. Institutional Barriers on Installing Home Chargers

In recent years, there are more newly-built housing estates include charging infrastructures in their car parks. However, the existing buildings, especially old buildings, are facing lots of installation barriers. As indicated by the senior executive and some of the interviewees, it is difficult to install chargers in carparks of these building due to lack of space. Space is also required for installing electricity supply facilities. The opposition from BMOs is another barrier. They are sometimes pessimistic to install chargers, who worried about fire risk and insurance problem. Some of them are concerned with the impact from EV charging on their workload.
Moreover, the scholar indicated that payment methods for charging services needed to be further discussed and unified. Since it is now forbidden to resell electricity in Hong Kong, most of the charging company charged the drivers either in an hourly or monthly basis. However, the payment channel varies. Some of them can be paid by bank transfer, while others can be paid by Octopus and cash. To promote home charging to the public, it is necessary to unified the payment methods for an easy and convenience way for the drivers to use.

6.4. Actual Experience of Early Adopters

Apart from the three influencing factors, evaluating the actual experience of early adopters are also important for a sustainable EV development. The satisfaction level on charging and driving habits and routines changes is discussed as follow.

6.4.1. Satisfaction Level on Charging

Most interviewees concern more about the recharging of EV after experiencing. Most of the interviewees charged their EV every 3 to 4 days, while some of them charged every 1 to 2 days (Figure 16). Over half of the interviewees sped less than 2 hours for charging EVs, while 4 of them spend 4 to 6 hours to charge and 3 of them spend over 8 hours for charging (Figure 17). It can be concluded that most of the interviewees charge 3 to 4 days and use less than 2 hours for charging each time.

Although the interviewees are satisfied with the charging time and do not show range anxiety, over half of them indicated that the chargers in Hong Kong was insufficient. They said that they usually spent half an hour to line up for a Supercharger, and the

time doubled on weekends. Some interviewees also indicated that the Superchargers are always fully occupied (Figure 18).

Figure 16: Frequency for the Interviewees to Charge EV

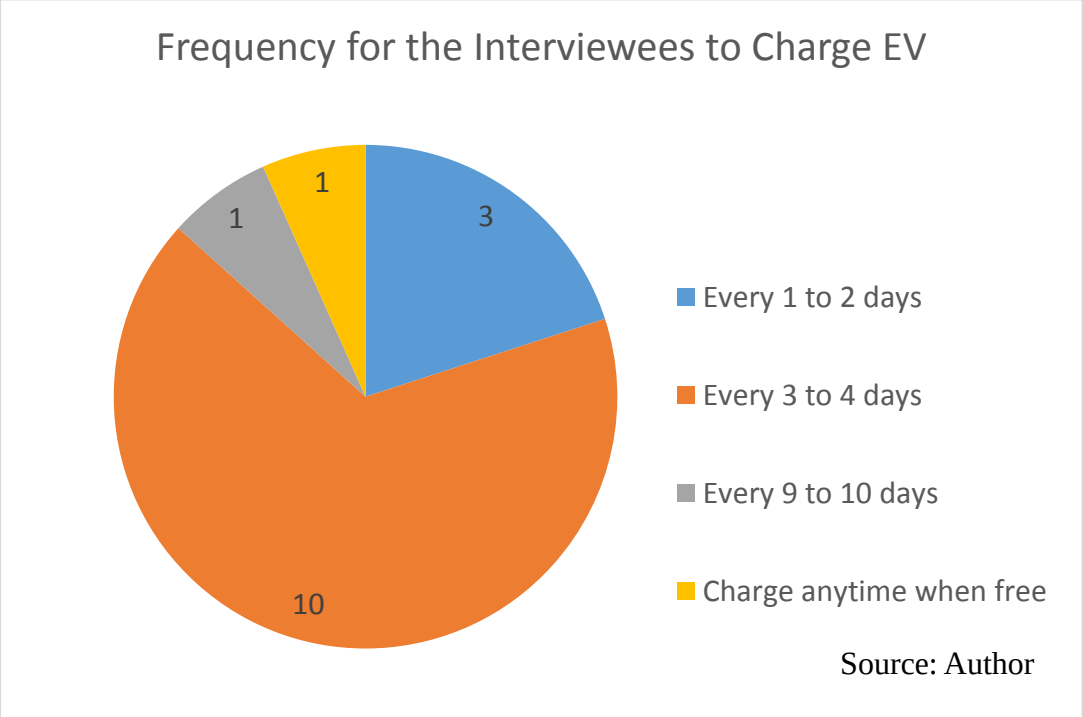


Figure 17: Time Spent by Interviewees for Charging EV

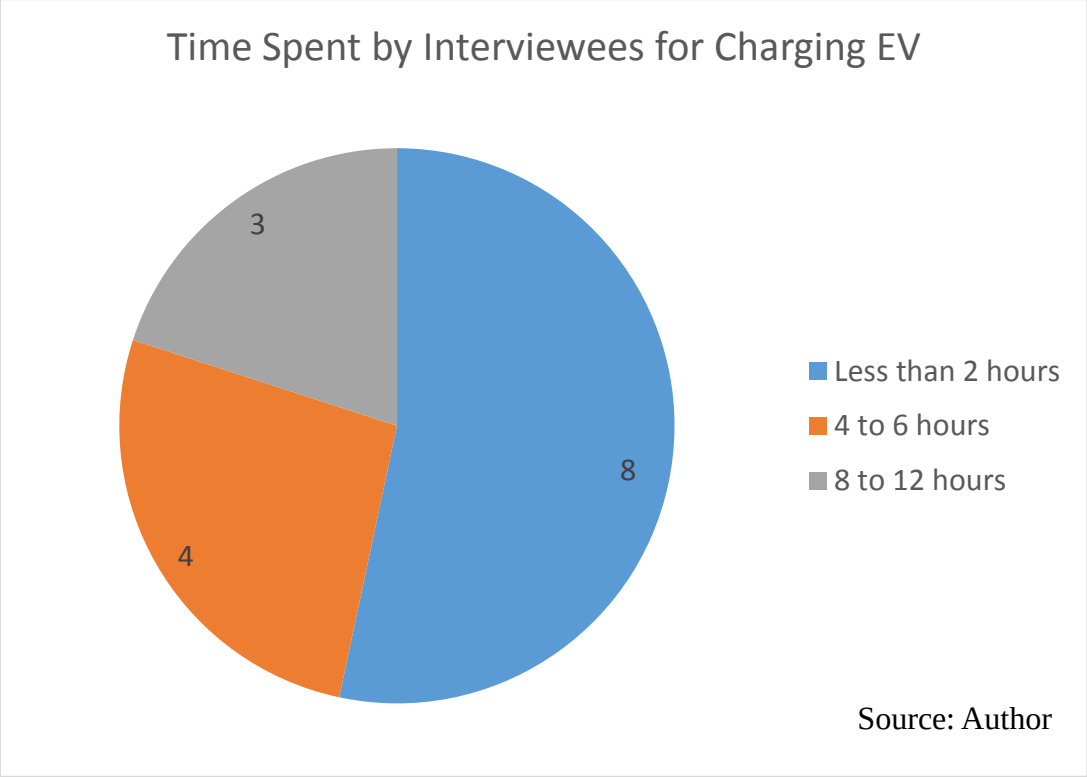
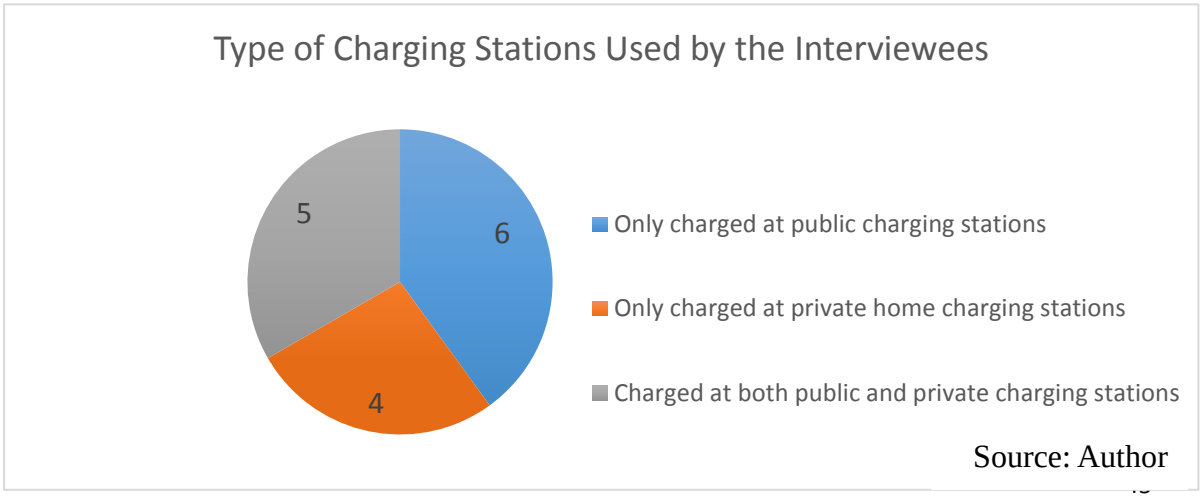


Figure 18: Fully Occupied Tesla Superchargers with Long Lines in Hong Kong Science Park

Source: Author

The satisfaction of interviewees in availability of public chargers shows a relationship with the access to home charging. There were 5 interviewees who mainly charged with private chargers at home and 4 interviewees who charged at both public and home private chargers (Figure 19). They were satisfied with the availability of public chargers. The rest only charged with public chargers, who mostly depends on fast charging Tesla Superchargers, did not satisfied with the availability of public chargers. They were satisfied with the location and charging speed of the public chargers, however, unsatisfied with the amount of public chargers.

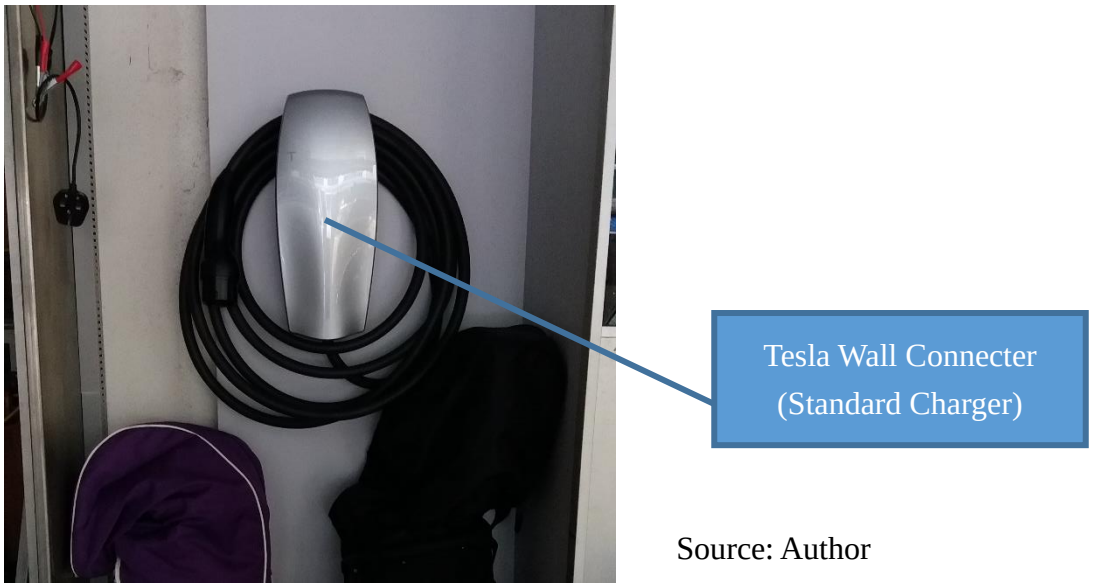
Figure 19: Type of Charging Stations Used by the Interviewees



Source: Author

The distinct satisfaction level from interviewees indicated the importance of home charging. With a private home charger, early adopters can charge their EV at home overnight. Time restriction on charging no longer exist as the EV can be charged whenever it is at home. Home chargers are usually standard or medium chargers (Figure 20) which balance the needs of early adopters and the cost of installation. For those only charge with public chargers, their EV can only be charged during daytime as public chargers mainly located at commercial and recreational area. They mostly depend on fast chargers as charging time need to be compressed for utilization of time.

Figure 20: A Tesla Wall Connecter (Standard Charger) Installed at a Village House in Yuen Long



Source: Author

6.4.2. Changes in Driving Habits and Daily Routine

After driving EVs, interviewees show a major change in driving behavior. They change from their driving speed to driving distance (Table 13). Most of the changes are caused by the reduction in lifetime cost, including fuel cost and tolls. Such results match with the Finding 6.1Cost is the Primary Concern.

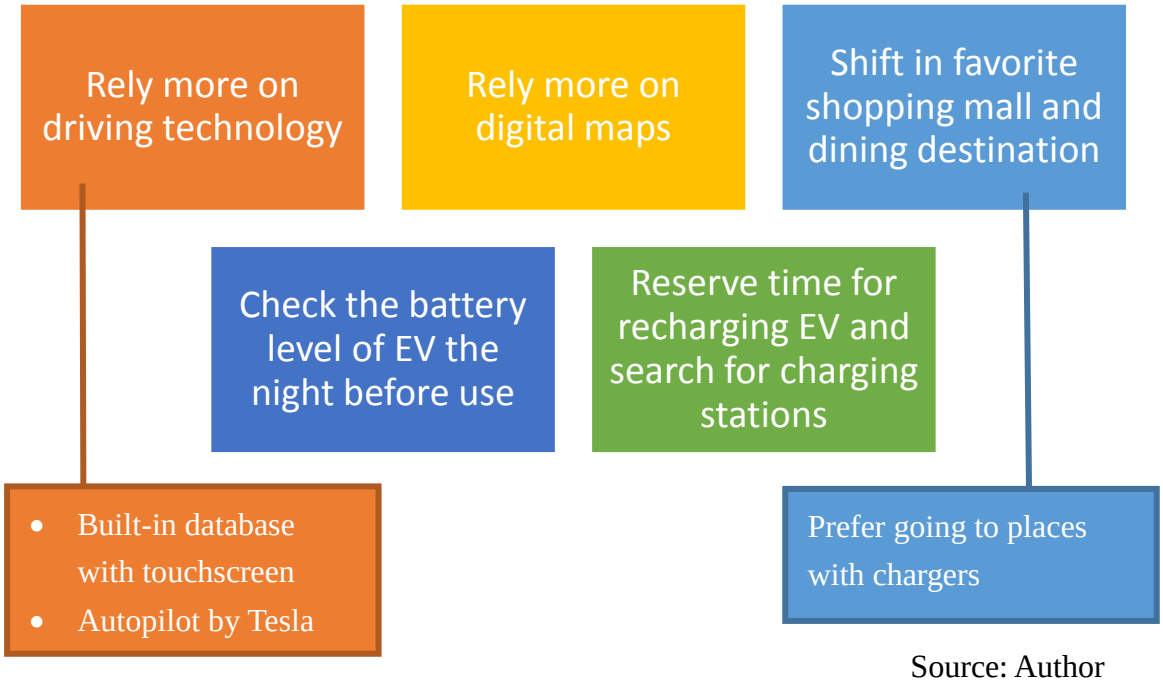
Table 13: Changes in Driving Habits and Cause of the Change

Driving Habits Changes	Cause of the Change
Drive more and faster	• Free / cheap recharging
Drive a longer distance to avoid passing through tunnels with tolls	• Free / cheap recharging • Avoid paying tolls
Choose the shortest driving route without considering the traffic condition (eg. more willing to use the Cross-Harbour Tunnel)	• EV does not consume fuel when stop on the road

Source: Author

Apart from driving habits, the early adopters indicated that there were some changes in their daily routines after they drive EV (Figure 21). They rely more on driving technology and digital maps when they drive. However, they indicated that Autopilot is also suitable for driving in tunnel due to the complicated road traffic in Hong Kong. There are some minor changes in their daily life in their EV experience, for example, shifting in favorite shopping mall and dining destination.

Figure 21: Changes in Daily Routines of EV Early Adopters



Source: Author

6.5. The Differences Between the case of Hong Kong and the Literature

From the literatures, there are three major factors influencing the decision of drivers to purchase EVs, including demographic, psychological, and situational. From the interviews, it is found that Hong Kong does not fully fit in the factors indicated by literatures.

Literatures indicate that the demographic characteristics of early adopters of EVs are wealthy young male with high education, fulltime job and contact with scientific community (Iana Vassileva, Javier Campillo, 2016) (Rogers, 1962) (Patrick Plötz, Uta Schneider, Joachim Globisch, Elisabeth Dütschke, 2014). The early adopters in the interviews generally consist with the literatures, however, they were mostly middle-aged male and limited connection with scientific community. Over half of the interviewees came from the middle income group, which indicated that the early adopters in the interviews were not very wealthy, but have a stable economic ability.

The psychological factors influencing the interviewees show a higher consistency with the literatures than other factors. They showed a very positive attitude towards green technology and willing to buy energy-saving products. However, their willingness to buy energy-saving products depends primarily on the cost and the payback period.
Except for the pricing of EVs, the other situational factors mentioned by the literatures are not the major influential factors to the interviewees. The interviewees expressed a distinct attitude towards the importance of pricing and the other situational factors. Access to information is not an influential factor to the interviewees, while performance and recharging of EVs is slightly influential to them.

From the above, it is clear that the demographic, psychological and situational factors influencing Hong Kong EV early adopters is not absolutely consistence with those indicated by foreign literatures. Hong Kong should formulate its own strategies according to the influential factors on the local consumers to scale up EVs in the market.

6. Conclusion and Policy Recommendations

EV is a green transport technology to reduce the roadside pollution in cities. In the deployment of an energy technology, the role of early adopters is critical as it determines whether the technology can pass through the commercialization valley of death and achieve in mass market. This is a study contributes to an integrated framework for analyzing the attitude and behaviors on early EV adopters in Hong Kong. The three major influential factors, demographic, psychological, and situational factors, are found to be interrelated with each other. Pricing, is the most influential factors to the above three factors.

From the research, it can be concluded that cost is the primary concerns for early EVs adopters in Hong Kong. The full waived in FRT is the major motivation for the early adopters to purchase EVs. The current policy of capping in FRT waiver inhibits their purchase desire. Psychological factors such as high awareness in environmental protection issues and willingness to purchase green technologies shows some effects on their purchase decision, but the desire of purchase decrease with increase in initial cost. Demographic characteristic of the interviewed early adopters showed a higher relative with their financial ability and stability rather than their interest in trying new technologies.

This study also discovered that there is a shortage of availability of public fast chargers, but not availability of public chargers as indicated by interviewees and the society. There was an unbalance ratio between standard chargers, medium chargers, and fast chargers. Most of the EV drivers flooded to charge at public fast charger, however, is the least available. There are also many managerial and institutional barriers on charging infrastructures, intensifying the congestion in public fast charging stations.

To mainstream EVs in Hong Kong, the concerns for purchasing EVs should be alleviated and motivations for purchase should be enhance in order to attract more drivers to be early adopters. Increasing satisfaction of experienced early EV adopters attract them to be the long-term majority adopters, which favors the growth of EV industry in Hong Kong. Only with developing a large of long-term adopters, mass adoption of EVs in Hong Kong can be achieved.

In order to scale up EV adoption in Hong Kong, initial cost of EV should be reduced. It should be decreased to a similar range with ICEVs in order to encourage a wide adoption in Hong Kong. Although the price of EV will drop when battery technology improves, which battery takes up most of the cost on EVs, it is a long term effect. Tax rebate is therefore should also be provided as short term measure, which financially motivates drivers to adopt EVs. It is the only and direct instrument to decrease the initial price of EVs in short term. The government should continuous to provide attractive tax incentives for purchasing EVs in order to mainstream EVs in Hong Kong.

Effective and efficient charging infrastructures management is also necessary to be implement in Hong Kong. Government should act as a coordinator. It can communicate with different charging service providers in order to discuss an optimal management system and charging regulations for the service users. This can avoid the complicated but diverse procedures when using public charging services at different locations and the misuse of charging infrastructures. Penalty and fines should apply to both EVs and ICEVs which misuse the charging infrastructures.

The amount of different type of public chargers should meet the needs of early adopters. In Hong Kong, more medium and fast public chargers are needed while amount of standard public chargers can be greatly reduced, according to the charging habits of early adopters. As many of the standard public chargers were installed by the two electricity companies, government can coordinate with them and discuss an optimal solution for providing types of chargers according to the needs of early adopters. Upgrading existing standard public chargers to medium and fast chargers will be the potential solution which minimize the pressure on land. Government can act as an incentive provider in order to motivate the market to put it in practice.

Encouraging home charging, especially in old buildings, will be another potential solution for alleviating the pressure on public fast chargers. The government can also work with those charging companies with good performance in the market for the solution. Charging companies can educate people about home charging and provide good quality charging services by using their expertise and experience. Government can reduce the institutional barriers and provide incentives for BMOs to introduce chargers in their car park, for example, set regulations for including green technology in buildings. It can also help in redeveloping car parks in old buildings to release space for installing charging infrastructures by providing subsides and engineering

experts.

Complexity in payment methods is another institutional barrier inhibiting the growth of charging business. Since it is forbidden to resell electricity due to regulations from electricity companies, the government can communicate and discuss with the electricity companies and charging companies to figure out an optimal and unified payment method for the charging industry. With a unified payment method, it will be easier for penetration of home charging in the market.

This is a research focusing on attitude and behavior of Hong Kong EV early adopters. It has applied a few methods for conducting the research, however, with a few limitations. First, the sample size for early adopters in Hong Kong is so small. There are 7,025 registered private EVs in Hong Kong, but the sample size for early adopters are 15. Such a small portion of interviewees may not reflect the real situation in Hong Kong. Furthermore, time for face-to-face interviews for early adopters are limited. Since they were invited on the street, some of them was in a hurry. Limited of interviewing time may lead to incomprehensive information collected.

It can be see that Hong Kong is moving to green transportation. There is increasing amount of EVs early adopters and EV is predicted to dominate the market in future decades. Although Hong Kong is still in its initial stage of EV deployment, a flourishing growth can be predicted in future years. With the support from government and market, EV is mainstreaming in the Hong Kong vehicle market, moving to a zero-emission city.

For future studies, researchers can focus on quantitative research. Collecting information and data from a broader database allows a more accurate analysis on whole Hong Kong. More site visits can also be conducted in order to gain information from early adopters all over Hong Kong.

Appendix

Appendix 1: Calculation of First Registration Tax of Private Cars in Hong Kong

Retail Price of Vehicles	Rate of Tax
On the first HK$ 150,000	40%
On the next HK$ 150,000	75%
On the next HK$200,000	100%
On the remainder	115%

Source: (Transport Department, 2005)

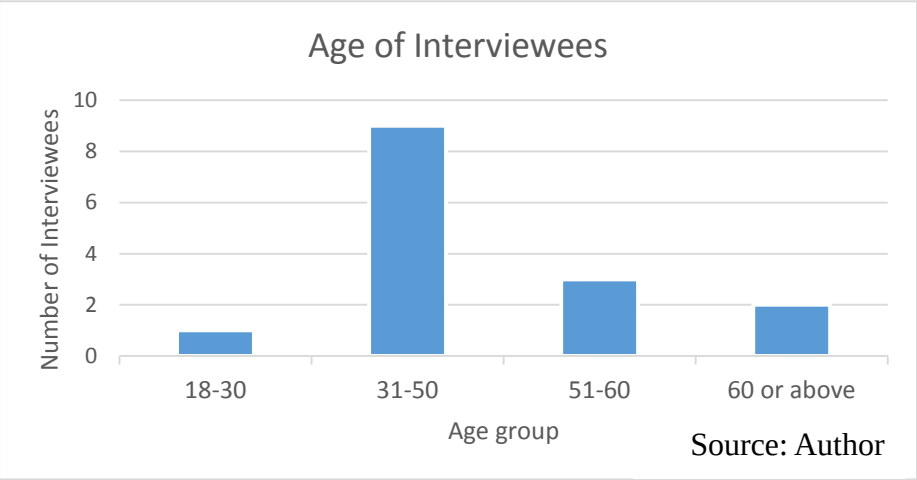
Appendix 2: Calculation of Annual Fee for Vehicle License of EVs and Private Car (Petrol) in Hong Kong

	Annual Fee (HK$)
Electric Vehicles:	
(a) not exceeding 1 tonne unladen weight; and	440
(b) an additional fee for each 250 kg unladen weight or part thereof	95
Private Car (Petrol), cylinder capacity of:	
(a) not exceeding 1,500 c.c.	3,929
(b) exceeding 1,500 c.c. but not exceeding 2,500 c.c.	5,794
(c) exceeding 2,500 c.c. but not exceeding 3,500 c.c.	7,664
(d) exceeding 3,500 c.c. but not exceeding 4,500 c.c.	9,534
(e) exceeding 4,500 c.c.	11,329

Source: (Transport Department, 2005)

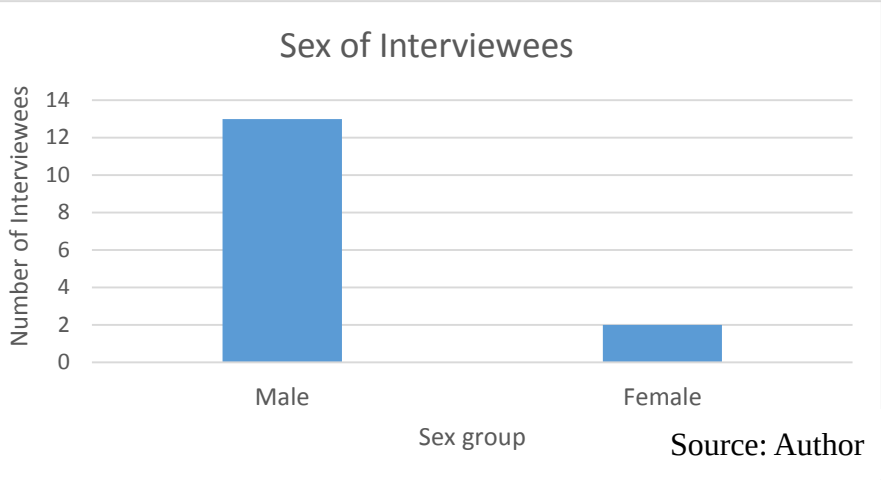
Appendix 3: Demographic Characteristic of Interviewees

Figure 22: Age of Interviewees



Source: Author

Figure 23: Sex of Interviewees



Source: Author

Figure 24: Education Level of Interviewees

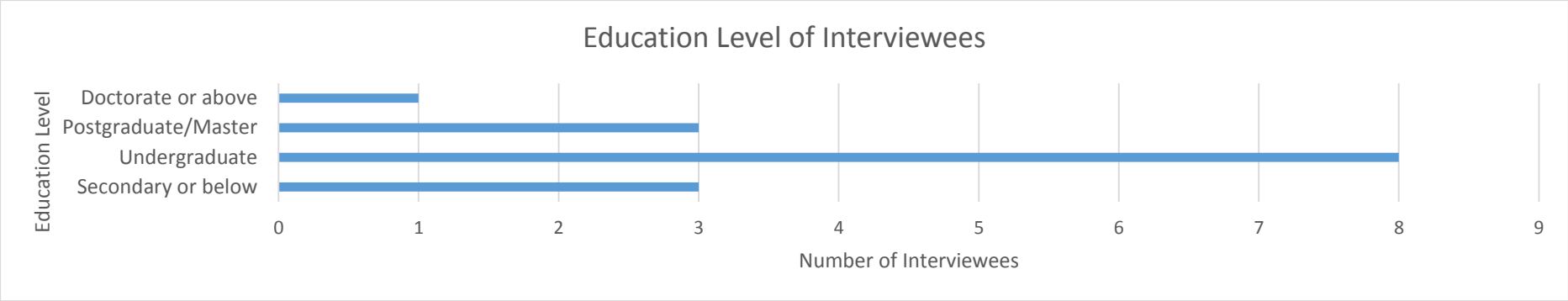
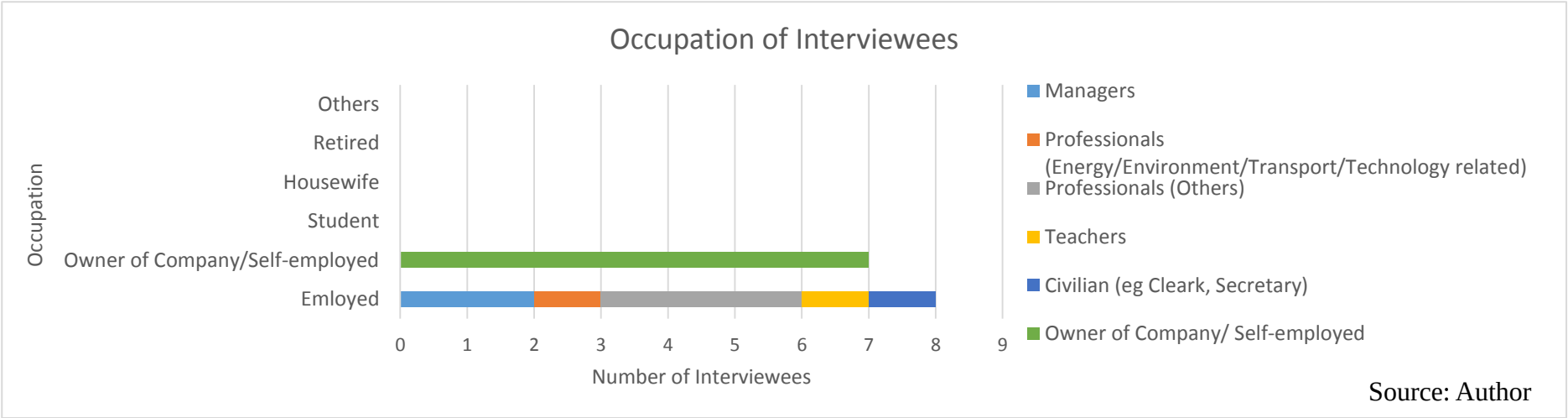
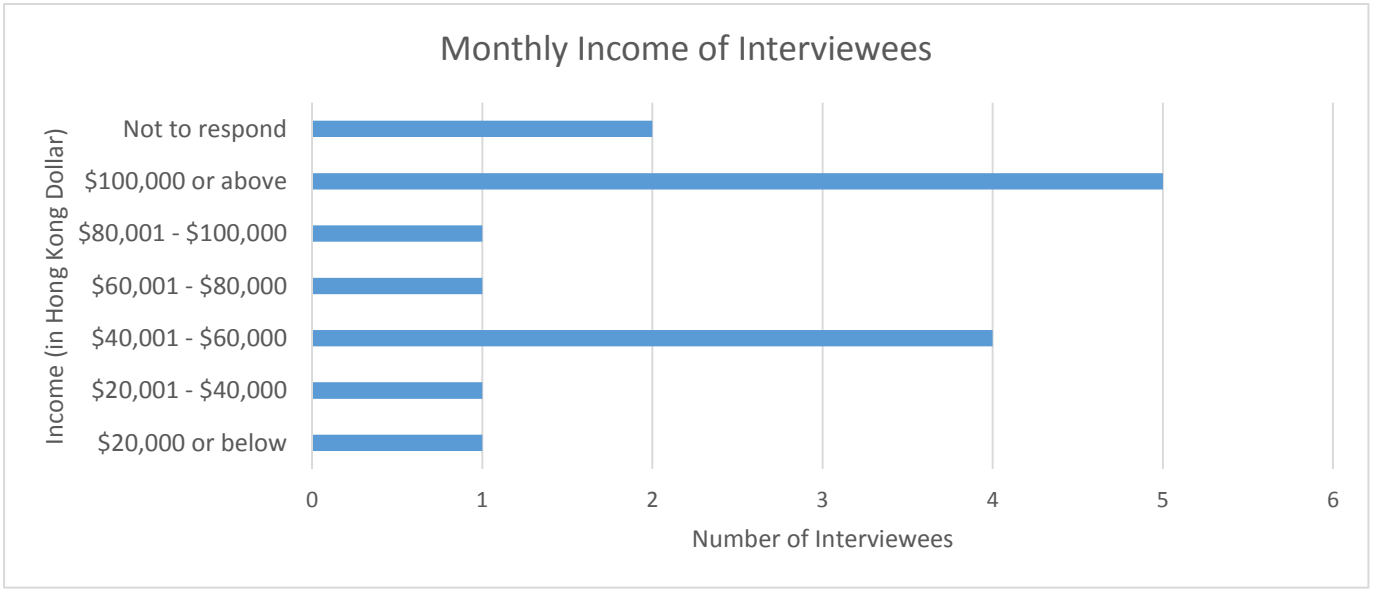


Figure 25: Occupation of Interviewees



Source: Author

Figure 26: Monthly Income of Interviewees



Source: Author

Appendix 4: Sample Interview Questions for Early Adopters

1. Basic demographic information
   i. Age
      A. 18-30
      B. 31-50
      C. 51-60
      D. 60 or above
   ii. Sex
      A. Male
      B. Female
   iii. Educational level
      A. Secondary or below
      B. Bachelor
      C. Postgraduate/Master
      D. Doctorate or above
   iv. Occupation
      A. Employed
         1. Managers
         2. Professionals (Energy/Environment/Transport/Technology related)
         3. Professionals (Others)
         4. Teachers
         5. Civilian
      B. Owner of Company/ Self-employed
      C. Student
      D. Housewife
      E. Retired
      F. Others
   v. Monthly income
      A. $20,000 or below
      B. $20,001 - $40,000
      C. $40,001 - $60,000
      D. $60,001 - $80,000
      E. $80,001 - $100,000
      F. $100,000 or above
      G. Not to respond

2. Lifestyle and attitudes
    i. Is this your EV? Is it your first and only car?
    ii. Are there any changes in your lifestyle after you purchase your EV?
    iii. Do you drive your EV for work or leisure?
3. Access to information
    i. How do you access to information such as sales, maintenance, and availability of charging infrastructures?
    ii. Is it easy for you to access the above information?
    iii. Do you have friends or relatives owning an EV? Do they affect your purchase?
    iv. Have you join any trial driving activities organized by any company?
4. Situational factors affection purchase desire
    i. Will the following affects your purchase desire?
        A. Initial cost and second hand value
        B. Maintenance and aftersales services
        C. Battery capacity, speed and performance, driving range
        D. Amount and location of chargers
    ii. If the cap of FRT waiver apply when you purchase your EV, will you still consider to purchase an EV?
    iii. Which of the above affects your purchase most?
5. Charging issues
    i. How frequent do you charge your EV?
    ii. How long do you spend on charging each time?
    iii. Do you often use public or private chargers for charging your EV?
    iv. Do you think there is enough charging stations in Hong Kong?
    v. How much do you spend on charging every month?
6. Attitude toward environmental protection
    i. Do you agree that burning fossil fuels will intensify global warming?
    ii. Do you agree that you have the responsibility to alleviate the problem of global warming?
    iii. Are you willing to spend more on energy-saving products?

Appendix 5: Sample Interview Questions for the Scholar

1. How would you comment on current EV development stage in Hong Kong?

2. What barrier do you think Hong Kong is now facing on mainstreaming EVs?

3. How would you comment on the current policy on capping FRT waiver for private EVs?

4. What do you think is the major concerns for early EV adopters in Hong Kong?

5. Do you think the Hong Kong government is committed to the EV development?

6. In what aspect do you think Hong Kong should focus on in order to mainstream EV?

7. What role should Hong Kong government, the two electricity companies, EV distributors, and charging companies plays in the process of EV penetration in the market?

8. How will you forecast the future EV development in Hong Kong?

9. Do you think that EV will eventually become the majority of vehicles in the private vehicle market in Hong Kong?

10. How long will you predict for EVs dominating Hong Kong market?

Appendix 6: Sample Interview Questions for the Senior Executive in a Charging Company

1. What is the motivation for the mother company, as an incumbent of electricity industry, of the charging company interested in joining this new industry?

2. What are the challenges of the charging company when expanding its business to different buildings and homes?

3. What are the concerns of BMOs and other consumers for installing private chargers?

4. Are there any corresponding measures provided by the company to alleviate the concerns of the costumers?

5. What is the business model of your company?

6. Do you think the free public charging affects your business?

7. How is the utilization rate and payback period of the chargers installed by your company?

8. Did the company receive any governmental incentives or support?

9. Do you think the capping in FRT waiver for EVs will affects your business?

10. In what aspect do you think the government should work on to support the charging industry?

11. How will you project the future business strategies and planning for the charging company?

References

CLP Power Hong Kong Limited . (2011, 1 20). CLP Inaugurates Partnerships for EV Leasing Scheme Initiative Expands CLP's support of electric vehicles in Hong Kong. *CLP Power Hong Kong Limited*.

Ajzen, I. (1991, 12). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), pp. 179-211.

Alyona Zubaryeva, Christian Thiel, Enrico Barbone, Arnaud Mercier. (2012, 11). Assessing factors for the identification of potential lead markets for electrified vehicles in Europe: expert opinion elicitation. *Technological Forecasting and Social Change, 9*(79), pp. 1622-1637.

Amsterdam Roundtable Foundation, McKinsey & Company. (2014). *Electric vehicles in Europe: gearing up for a new phase?* Amsterdam Roundtable Foundation.

Bakker, J. J. (2011). *Contesting range anxiety: The role of electric vehicle charging infrastructure in the transportation transition.* Eindhoven: Eindhoven University of Technology.

Ben Lane, Stephen Potter. (2007). The adoption of cleaner vehicles in the UK: exploring the consumer attitude–action gap. *Journal of Cleaner Production, 15*(11-12), pp. 1085-1092.

Bjart Holtsmark, Anders Skonhoft. (2014, October). The Norwegian support and subsidy policy of electric cars. Should it be adopted by other countries? *Environmental Science & Policy, 42*, pp. 160-168.

Bjart Holtsmark, Anders Skonhoft. (2014). The Norwegian support and subsidy policy of electric cars. Should it be adopted by other countries? *Environmental Science & Policy*(42), pp. 160-168.

Byrne, Michael Raymond; Polonsky, Michael Jay. (2001, 12 21). Impediments to consumer adoption of sustainable transportation: Alternative fuel vehicles. *International Journal of Operations & Production Management; Bradford, 21*(12), pp. 1521-1538.

Central Policy Unit, H. (2015). *Study Report on Promoting Ecar in Hong Kong.* Hong Kong.

Chan, P. (2017, 2 22). The 2017-18 Budget. Hong Kong Special Administrative Region.

CLP Power Hong Kong Limited. (2015). *Typical Electric Vehicle Charging Methods.* Hong Kong.

CLP Power Hong Kong Limited. (2016, 11 24). CLP Power Extends Electric Vehicle Charging Network as Popularity of Green Motoring Accelerates.

CLP Power Hong Kong Limited. (2017). *Eco Charge.* Hong Kong.

Connelly K, ur Rehman Laghari K, Mokhtari M, Falk T.H. (2014). Approaches to Understanding the Impact of Technologies for Aging in Place: A Mini-Review. *Gerontology, 60*(3).

Diamond, D. (2009, March). The impact of government incentives for hybrid-electric vehicles: Evidence from US states. *Energy Policy, 37*(3), pp. 972-983.

Electrification Coalition. (2009). *Electrification Roadmap.* Electrification Coalition.

Environmental Protection Department. (2011). *The Statutory Ban against Idling of Motor Vehicle Engines.* Hong Kong.

Environmental Protection Department. (2017, 1). EV Chargers locations. Hong Kong.

Environmental Protection Department. (2017). EV Models in Hong Kong. *Promotion of Electric Vehicles in Hong Kong*.

Environmental Protection Department. (2017, 1). Locations of Charging Stations for Electric Vehicles.

EPD, E. P. (2016). *2014 Hong Kong Emission Inventory Report.* Hong Kong: Environmental Protection Department.

Erik Figenbaum, Terje Assum, Marika Kolbenstvedt. (2015, 7 3). Electromobility in Norway: Experiences and Opportunities. *Research in Transportation Economics*, pp. 29-38.

EV Power Group. (2016, 5 5). The Challenge of Developing EV Charger Network in a City.

Franziska Buhler, Peter Cocron, Isabel Neumann, Thomas Franke, Josef F. Krems. (2014). Is EV experience related to EV acceptance? Results from a German field study. *Transportation Research Part F*, pp. 34 - 49.

Gordon Ewing, Emine Sarigollu. (2000). Assessing Consumer Preferences for Clean-Fuel Vehicles: A Discrete Choice Experiment. *Journal of Public Policy & Marketing, 19*(1), pp. 106-118.

Green, R. M., & John, M. (1997). *United States Patent No. 5,642,270.*

HK Electric Investments. (2016, 9 28). New Initiatives to Make EV Charging Easy. *HK Electric Investments*.

HKT Limited, CLP Holdings Limited. (2016, 8 22). HKT and CLP new joint venture Smart Charge brings one-stop electric vehicle charging solutions to Hong Kong.

Hong Kong Electric Investment. (2010, 10 29). EV Leasing Scheme and Test Drives to Promote Wider Use of EVs in Hong Kong. *Hong Kong Electric Investment*.

Hong Kong EV Power Limited. (2016). *Professional EV Charging Services in Residential Buildings.*

Hongkong Electric Company Limited. (2010). *2009 Annual Report.* Hong Kong:

Hongkong Electric Company Limited.

Hongkong Electric Company Limited. (2016, 9 28). New Initiatives to Make EV Charging Easy.

Iana Vassileva, Javier Campillo. (2016). Adoption barriers for electric vehicles: Experiences from early adopters in Sweden. *Energy*.

IEA, I. E. (2016). *Global EV Outlook 2016.* France: International Energy Agency.

Jeff Sommerfeld, Laurie Buys, Desley Vine. (2017). Residential consumers' experiences in the adoption and use of solar PV. *Energy Policy, 105*, 10-16.

Jonn Axsen, Kenneth S Kurani. (2012). Interpersonal influence within car buyers' social networks: applying five perspectives to plug-in hybrid vehicle drivers. *Environment and Planning*(50), pp. 1047-1065.

Lee, C. (2007, 9). Transport and climate change: a review. *Journal of Transport Geography, 15*(5), pp. 354-367.

Legislative Council. (2016, 1 27). *Promoting the wider use of electric buses.* Hong Kong: Legislative Council of Hong Kong.

Lester Richard Keith, David Hart. (2012). *Unlocking energy innovation: How America can build a low-cost low-carbon energy system.* Cambridge: MIT Press.

Leung, C. K. (2016). *Smart Ev Charge Easy Upgrade Service.* Hong Kong: Hongkong Electric Company Limited.

Marie Aarestrup Aasness, James Odeck. (2015, 12). The increase of electric vehicle usage in Norway—incentives and adverse effects. *European Transport Research Review*.

National Academies of Sciences, Engineering, and Medicine. (2016). *The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies.* Washington, DC: The National Academies Press.

Nuri Cihat Onata, Murat Kucukvarb, Omer Tatari. (2015, 7 15). Conventional, hybrid, plug-in hybrid or electric vehicles? State-based comparative carbon and energy footprint analysis in the United States. *Applied Energy, 150*, pp. 36-49.

Ona Egbue, Suzanna Long. (2012, 9). Barriers to widespread adoption of electric vehicles: Ananalysis of consumer attitudes and perceptions. *Energy Policy, 48*, pp. 717-729.

Patrick Plötz, Uta Schneider, Joachim Globisch, Elisabeth Dütschke. (2014, 7 30). Who will buy electric vehicles? Identifying early adopters in Germany. *Transportation Research Part A*.

Petter Haugneland, Hans Håvard Kvisle. (2015, 1). Norwegian electric car user experiences. *International Journal of Automotive Technology and*

Management, 15(2).

Regional Environmental Center. (2004). *Promotion of Climate Change Policies in Turkey.* Turkey.

Ricardo Faria, Pedro Moura, Joaquim Delgado, Anibal T. de Almeida. (2012, September). A sustainability assessment of electric vehicles as a personal mobility system. *Energy Conversion and Management, 61*, pp. 19-30.

Ritsuko Ozaki, Katerina Sevastyanova. (2011, 5). Going hybrid: An analysis of consumer purchase motivations. *Energy Policy, 39*(5), pp. 2217-2227.

Robert L. Hirsch, Roger Bezdek, Robert Wendling. (2005). *Peaking of World Oil Production: Impacts, Mitigation, & Risk Management.* U.S. Department of Energy National Energy Technology Laboratory.

Rogers, E. M. (1962). *Diffusion of innovations.* New York: Free Press of Glencoe.

Ross Marlin Green; Michael John Kellaway. (1997). *Battery powered electric vehicle and electrical supply system.* United States.

Smart Charge. (2016). *Our Project.* Retrieved from Smart Charge.

Stern, P. C. (2000). Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues, 56*(3), pp. 407 - 424.

Telsa Guide HK. (2017). Do you need to pay for charging? Hong Kong.

Tesla. (2017). *Tesla Superchargers in Hong Kong.* Hong Kong: Tesla.

Tesla Guide HK. (2017). *How much you can save for vehicle licence for Electric Vehicles?*

Tesla Motors HK Limited, T. (2014). *Resale Value Guarantee.* Tesla Motors HK Limited.

The City of New York. (2010). *Exploring Electric Cehicle Adoption in New York City.* New York.

The University of Hong Kong. (2017). Hedley Environmental Index. Hong Kong.

Thomas Franke, Franziska Bühler, Peter Cocron , Isabel Neumann, Josef F. Krems. (n.d.). *Enhancing sustainability of electric vehicles: A field study approach to understanding user acceptance and behavior.* UK: Ashgate: Advances in Traffic Psychology. Farnham.

Transport Department. (2005). *Fees & Charges.*

Transport Department. (2010). *Registration and Licensing of Vehicles by Fuel Type (August 2010).* Hong Kong: Transport Department.

Transport Department. (2017). *Registration and Licensing of Vehicles by Fuel Type (January 2017).* Hong Kong: Transport Department.

Walter Leal Filho, Richard Kotter. (2015). *E-Mobility in Europe: Trends and Good Practice.* Springer.

WHO, W. H. (2006). *WHO Air quality guidelines for particulate matter, ozone,*

nitrogen dioxide and sulfur dioxide. World Health Organization.

Zeinab Rezvani, Johan Jansson, Jan Bodin. (2015, 1). Advances in consumer electric vehicle adoption research: A review and research agenda. *Transportation Research Part D: Transport and Environment*(34), pp. 122-136.

Zhen-Yu She, Qing Sun, Jia-Jun Ma, Bai-Chen Xie. (2017, 5). What are the barriers to widespread adoption of battery electric vehicles? A survey of public perception in Tianjin, China. *Transport Policy, 56*, pp. 29-40.