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Factors affecting electric vehicle adoption intention: The impact of objective, perceived, and prospective charger accessibility

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Abstract: In the era of e-mobility, promoting electric vehicle (EV) usage is considered a policy worth incorporating into a government's agenda. While accessibility has been broadly recognized as important for user intention to adopt EVs, few studies have considered how accessibility affects public acceptance of EVs. This study measures the objective, perceived and prospective accessibility of public EV charging facilities, investigating how and to what extent this novel set of accessibility measures affects the EV adoption intention of individuals. The data are primarily derived from a recent questionnaire survey of driver license holders in Hong Kong administered to both EV owners and non-EV owners. Objective accessibility is measured by the number of (population-weighted) Tesla and standard chargers publicly available within five minutes walking distance of an individual's residential district and subjective (i.e., perceived and prospective) accessibility is measured by four Likert-scale questions. The results show that objective accessibility significantly and substantially influences an individual's intention to purchase an EV. Meanwhile, both perceived and prospective accessibility are highly significant for the adoption intention of non-EV owners. We also observe significant effects for perceived and prospective driving ranges, environmental consciousness and prior experience with EVs. This study provides a valuable reference for the impact of the accessibility of public EV chargers on EV adoption in the context of a high-density Asian city. Based on the findings, we propose various policy recommendations that integrate accessibility planning strategies into EV promotion in cities that aspire to expand e-mobility.

Keywords: Electric vehicle (EV), charging facilities, accessibility, public acceptance, Hong Kong

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1 Introduction

Academics and industrial actors have emphasized electric vehicles (EVs) as a means of mitigating greenhouse gas emissions and balancing energy consumption (Environmental Protection Department, 2019; Plötz et al., 2014). To effectively promote EV use, it is crucial to boost adoption. In the case of Hong Kong, the government has launched a series of policy strategies designed to encourage EV usage, including full exemption from the first registration tax for EVs, subsidies for electric buses, a steering committee for EV promotion and financial incentives for individual consumers. Nonetheless, in the first half of 2021, EV sales accounted for only 17.8% of the private vehicle market (Transport Department, 2021). Compared to other countries, such as Norway, where 49.1% of newly registered passenger cars were pure EVs or plug-in EVs (Lambert, 2019), Hong Kong's EV market remains in its infancy, demanding more planning tools to stimulate adoption.

Optimal deployment of charging facilities can critically impact the adoption decisions of potential EV users. In fact, the challenge of recharging EVs has been recognized as the main barrier to EV diffusion in the Hong Kong market (Hong Kong Productivity Council, 2014). Distinct from the home-based charging scenarios prevalent in Western countries, where people can directly install a charging point in their garage, home-based charging is hard to achieve in Hong Kong because residential parking bays are generally managed by a property management company or the building owners' corporation. Meanwhile, the conservative attitude of managing organizations – due to safety concerns and reluctance to deplete a building's power reserves – has prevented charger installation in residential car parks, especially where the notion is pushed by renters (Electric Vehicles Promotion and Charging Infrastructure Committee, 2019). Therefore, most EV drivers have to charge their EVs at the public charging points found in public parking lots, commercial buildings, shopping malls and hotels. To offer convenient charging options at trip destinations, the Hong Kong government has promoted workplace charging for drivers without access to charging outlets at their residence. This suggests that the spatial planning of public EV chargers to improve accessibility is critical for Hong Kong's drivers, especially in the case of remote areas, where EV chargers are further limited.

Considerable progress has been made in terms of accessibility measurements during the past three decades. However, although comprehensive accessibility indicators have been developed for objective attributes such as travel time, distance and utility value, research into subjective accessibility remains scarce (Curl et al., 2011; Lattman et al., 2016a; Van Wee, 2016). This may obscure the subjective attractiveness of a facility or activity. For example, the distance to an EV charger might seem much shorter when the route is pleasant, potentially stimulating a potential user's purchase intention. This aligns with the argument of some scholars that subjective accessibility can represent the perceived ease of actualizing a transit demand (Cheng & Chen, 2015; Lattman et al., 2016a). Therefore, we believe that including subjective charger accessibility alongside the classical measurements can enhance behavioral realism. Accordingly, this study investigates the effects of both objective and subjective accessibility on EV adoption intention in Hong Kong. Building on expectation confirmation theory (ECT), this study incorporates the two subjective accessibility measures of perceived accessibility and prospective accessibility to better understand EV adoption intention. The study also considers user heterogeneity.

The rest of this paper is structured as follows. Section 2 reviews the literature concerning major factors affecting EV adoption and considers the definitions of accessibility developed by transportation studies. Section 3 describes our study context, questionnaire design and methodology. Section 4 presents a basic descriptive summary, and Section 5 elucidates the quantitative modeling results and qualitative survey interpretation. Finally, Section 6 summarizes our findings and discusses their potential policy implications for Hong Kong's future EV planning.

2 Literature review

2.1 Factors affecting EV adoption intention

Employing the notion of "consumer adoption" in reference to the behavioral response to technological innovations (Huijts et al., 2012; Schuitema et al., 2013), we define EV adoption as the intention to purchase and use EVs. The literature has extensively discussed potential factors and mechanisms influencing EV adoption intention, enabling the distinction of three main dimensions: technological, social-demographic and psychological attributes.

Among technological considerations, the limited driving range has proven the biggest barrier to mass EV diffusion (Danielis et al., 2020; Haustein & Jensen, 2018; Lieven et al., 2011; Moons & De Pelsmacker, 2012). The driving range of an EV is usually smaller than that of conventional cars. Therefore, for users, EV adoption involves more than simply changing vehicle model: they need to consider the restricted driving range and additional recharging time compared to conventional fuel-powered vehicles. Furthermore, EV users need to pay attention to the dynamic battery level and implement a charging routine to recharge the EV whenever possible. Range anxiety, that is, the fear of insufficient battery power to reach the destination, is thus attributed and has been acknowledged of great importance in affecting users' intention to adopt EVs (Anable et al., 2011; Sun et al., 2022). The link between range anxiety and access to charging facilities has been further established via empirical testing, with the former found to be moderated by additional access to charging infrastructure (Neubauer & Wood, 2014).

Consumer adoption of EVs varies according to different social-demographic characteristics, including gender, age, income, and education. An extensive literature surveying the social-demographic backgrounds of potential or pioneering EV users reveals that they are distinct from the mainstream conventional car buyers. The most common traits considered have been age and gender, with middle-aged men observed to be the most likely EV purchasers (Carley et al., 2013; Plötz et al., 2014). Highly educated persons and full-time workers with higher incomes have also demonstrated stronger interest in EV adoption (Egbue & Long, 2012; Haustein & Jensen, 2018; Morton et al., 2017).

Psychological factors are also of substantial importance and include both individual preferences and attitudes towards EVs. For instance, users with a strong environmental consciousness are more likely to buy or support EVs due to their environmentally beneficial image (Dong et al., 2020; Priessner et al., 2018; Schuitema et al., 2013). Similarly, the findings of Axsen et al. (2016) revealed that pioneering adopters tend to have a stronger environmental awareness than less enthusiastic groups, and those of Carley et al. (2013) associated EV affinity with high levels of environmental sensitivity. Furthermore, consumer attitudes towards EVs are largely affected by their prior knowledge of and experience with EVs. It is expected that adoption intention is partly derived from the perceived risks or difficulties associated with a relatively innovative product, which users calculate based on prior experience, emotions, and media sources (Egbue & Long, 2012; Oliver & Rosen, 2010; Sun et al., 2022). The before-and-after survey conducted by Jensen et al. (2013) yielded concrete evidence on the significant promotional effect of EV trial experience on an individual's purchase preference. Burgess et al. (2013) facilitated a similar trial scheme to enable qualitative understanding of the sustained contribution of first-hand experience to producing a positive view of EVs.

However, few EV adoption studies have carefully examined the role of charger accessibility, despite the research emphasizing factors such as driving range and recharging time as main hurdles to EV adoption intention (Axsen et al., 2016; Burgess et al., 2013; Caperello & Kurani, 2011; Carley et al., 2013; Graham-Rowe et al., 2012; Jensen et al., 2013; Priessner et al., 2018; Schuitema et al., 2013). In recent years, several scholars have reported a positive effect of the availability of accessible EV chargers for predicting EV adoption (e.g., Axsen et al., 2016; Skippon & Garwood, 2011; Sun et al., 2022). However, a simple dichotomy remains far from sufficient for understanding how and to what extent charger accessibility could affect public acceptance of EVs in Hong Kong.

2.2 Objective and subjective accessibility

Before investigating the possible effect of accessibility on public acceptance of EVs, it is important to specify what accessibility means and how it can be measured. Accessibility has been explicitly investigated in transport planning research for over 30 years. Hansen (1959) proposed the earliest definition, conceiving of accessibility as "the potential for interactions." Later researchers introduced theoretical and practical approaches to improve understanding of objective accessibility and developed now-classical accessibility indicators, which usually relate to two components: travel cost and attractiveness of destinations (e.g., Páez et al., 2012). The different methods of measuring accessibility can be roughly grouped into four categories: (1) distance-based measures, such as Euclidean distance, network distance, travel time, and travel cost, which treat accessibility as the connectedness of two separate places based on distance alone; (2) cumulative opportunity, which simply counts the opportunities to access destinations or amenities, such as jobs, shops, and social services, within a specified travel time (e.g., 20, 30, 40 min) or distance (e.g., half a mile) of a focal point; (3) gravity-based approaches, which use a continuous distance decay function to reflect travel impedance; and (4) utility-based measures, which capture the net utility for an individual within a given area. An exhaustive review of objective accessibility measurements is not the focus of this study and comprehensive reviews of such measurements are available elsewhere (e.g., Curtis & Scheurer, 2010; Geurs & Van Wee, 2004; Handy & Niemeier, 1997; Páez et al., 2012; Pirie, 1979).

Beyond objective accessibility, we use ECT to derive two subjective measures of accessibility: perceived and prospective (or anticipated) accessibility. Marketing research has extensively recognized ECT as a robust theory for explaining consumer purchase behaviors and recommendation intentions (Hossain & Quaddus, 2012; Thong et al., 2006), and it provides a useful theoretical framework that supports the underlying mechanism of subjective accessibility and EV adoption intention. ECT hypothesizes that a consumer's satisfaction with a certain product or service determines their repurchase or adoption intention (Oliver, 1980). Consumer satisfaction is based on the discrepancy between initial expectation and perceived performance post-consumption. A positive confirmation (and enhanced consumer satisfaction) describes the perceived performance matching or exceeding initial expectations.

Unlike conventional accessibility analysis, which focuses on the spatial proximity of facilities, the literature has not frequently explored the concept of subjective accessibility. Morris et al. (1979) first distinguished objective accessibility from perceived accessibility, claiming that perceptions of accessibility represent the "the real determinants of behavior." However, perceived accessibility research has received limited attention, partly because it is harder to quantify and most evidence is anecdotal (Curl et al., 2011). According to Van Wee (2016), introducing perception into accessibility studies constitutes a major research challenge for the next two decades. These studies have motivated this paper's combination of objective and subjective accessibility in pursuit of a more complete understanding of accessibility issues in EV research.

The limited research on subjective accessibility has adopted different measurement approaches. For example, Lotfi and Koohsari (2009) measured subjective accessibility by simply asking participants to rate their accessibility satisfaction at one of four levels: very good, good, moderate or low. Curl et al. (2011) used semi-structured interviews to differentiate perceptions of accessibility from potential (objective) accessibility, arguing that potential accessibility does not necessarily lead to realized perceived accessibility for all groups of people. Although not clearly articulated in terms of perceived accessibility, Carley et al. (2013) examined respondents' awareness of EVs and infrastructure in relation to their intent to purchase a plug-in EV. Cheng and Chen (2015) operationalized the perception of accessibility as the perceived difficulties experienced by urban travelers in accessing public transport stations and itemized the several components of perceived accessibility: network coverage, weather conditions, and walkable environment. They found that a stressful walking environment for pedestrians posed a particularly significant barrier to the use of public transport. To explore perceived accessibility in relation to social wellbeing and social inclusion, Lattman et al. (2016b) defined perceived accessibility as "how easy it is to live a satisfactory life using the transport system." Accordingly, they proposed a Perceived Accessibility Scale. This 7-point Likert scale captured four aspects of perceived accessibility by a particular transport mode: ease of travel, perceived possibilities of travel, perceived opportunities to travel to activities of interest, and overall satisfaction with accessibility.

The literature discussed informs our study's incorporation of both objective and subjective accessibility into its investigation of EV adoption intention in Hong Kong. Accordingly, for the objective measure, we use a population-weighted measure of proximity to public EV chargers. For subjective accessibility, we consider consumers' current perceived accessibility and their perceived prospective accessibility, namely, in the next five years.

3 Materials and methods

3.1 Study context

Hong Kong is a Special Administrative Region of China which borders Shenzhen to the north. The city has a total land area of 1,106 square kilometers and a population of 7.4 million in 2017. As of September 2019, there were 2,503 public EV chargers in Hong Kong (Environmental Protection Department, 2019). The Hong Kong government classifies EV chargers within the territory into three levels of charging power: standard, medium, and quick. Standard chargers are attached to a household socket; these can also be referred to as level 1 chargers (or slow chargers in Europe) (Neubauer & Wood, 2014; Transport for London, 2017). Remaining chargers are divided by their power supply: medium chargers are those supplying 20kW or lower, and quick chargers are those supplying above 20kW power. Due to difference in classification standards, level 2 chargers (or fast chargers in Europe) would be defined as medium or quick chargers. Also, as Hong Kong does not specify a separate class of DC chargers, level 3 chargers (or rapid chargers) are grouped into the quick charger category. A given charger can recharge one EV at a time.

Among the public chargers, 467 were Tesla Superchargers or Wall Connectors managed by Tesla. While all Superchargers meet the standard of quick chargers, Wall Connectors are classified into both medium and quick chargers depending on their specifications. Tesla dominates the EV market share in Hong Kong: of the 581 new electric private cars registered in June 2021, 500 were Tesla EVs (Transport Department, 2021), and as of 2016 the city had the highest rate of Teslas per capita in the world (Woodhouse, 2018). Due to Tesla's exclusive charging cable design and charging payment method, Tesla EV owners can recharge their vehicles at city-wide EV outlets – including both Tesla and non-Tesla chargers – whereas drivers of other EVs have no access to the 108 high-power Tesla Superchargers.

Public charging stations in Hong Kong are typically located in public car parks (He et al., 2022) and feature an average of 7.4 chargers as of September 2019 (Environmental Protection Department, 2019). Figure 1 shows the distribution of charging stations in Hong Kong, demonstrating that the core urban areas on either side of Victoria Harbor receive ample coverage of the charging network, whereas the New Territories lack adequate charger supply despite the large population demand and land area.

The Hong Kong government has promulgated various policy approaches to promote EV adoption.

The earliest example was announced before the sovereignty transfer, with the full exemption from the first-vehicle registration tax introduced in 1994. That tax exemption was replaced by a HK$97,500 concession and the "One-for-One Replacement" Scheme in 2018, which offered a higher tax concession for replacing internal combustion engine (ICE) vehicles with an EV. Furthermore, in 2011, the Hong Kong government announced its target of achieving 30% EV market share and equipping 30% of parking lots with charging outlets. Though the initiative remains far from actualization, the Hong Kong 2030+ visionary plan recognizes the provision of more EV charging facilities as a means of building a smart and green city. To facilitate charger supply, the government has also opened car parks in governmental buildings for charging outside office hours. Thus, it is expected that Hong Kong's charging network will continue to be expanded and enhanced.

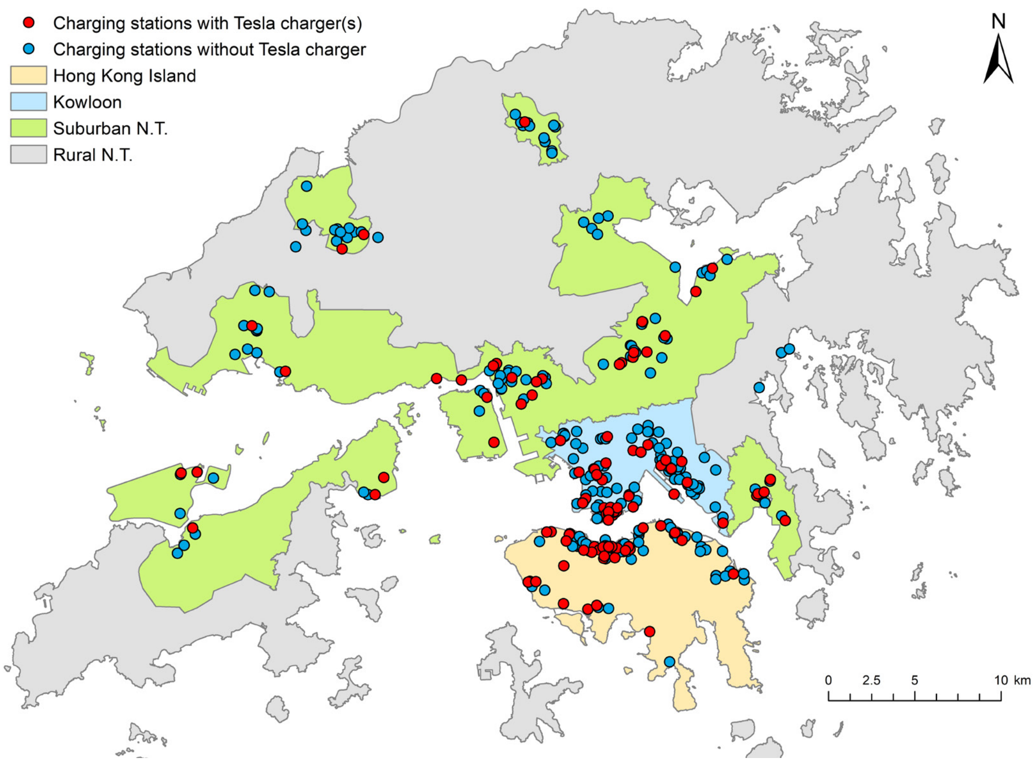

Figure 1. EV charger distribution in Hong Kong

3.2 Questionnaire design and data

An online survey was designed to recruit licensed drivers in Hong Kong, who constituted around 30.8% of the total population by the time we conducted the survey (Census and Statistics Department, 2020; Transport Department, 2021). This group was identified as potential EV users because they are likely to consider purchasing an EV or transferring from a conventional car to an EV. The online survey was conducted in Hong Kong from February to May 2019. The research team approached EV owners from various associations via online and offline means throughout the survey period, including EV user alliances, social media communities, and online forums, with the holistic recruitment of licensed drivers in general performed towards the end of the period via an online survey company. Samples from the survey company were recruited from their survey panelist pool by disseminating the survey to panelists qualified for our sample group (licensed drivers) and imposing a 50% quota of car owners.

A total of 982 valid samples were collected from all sources, of which 804 responses were supplied by the survey company, and 178 responses were collected by the research team. The survey operated by the survey company was completed with a 75% response rate, and the average interview length was nine minutes. The whole sample was further divided into EV owners (N=238), ICE vehicle owners (N=327), and licensed drivers who did not own a car (N=417). The last two groups (N=744) were combined into a single target group in the three models. We modified a survey on EV adoption used in Denmark (Thøgersen & Ebsen, 2019) to suit the Hong Kong context. The survey data collected from each participant included a score ranging from 1 to 7 for adoption intention, socio-economic attributes affecting EV adoption, responses to five statement questions quantifying subjective accessibility on 7-point Likert scale, and a response to an open-ended question concerning further EV planning improvements. Based on the key factors identified by the literature review, besides the accessibility measurements, four main categories of explanatory factors were incorporated into the questionnaire: 1) Personal characteristics, including gender, age, education attainment, marital status, employment status, and income; 2) Household characteristics, including car ownership, household size, and housing tenure; 3) Environmental consciousness, measured by whether the interviewee was affiliated with any environmental group; 4) Prior EV experience as a driver or passenger; and 5) Location information, including residence district and workplace district, which enable calculation of objective accessibility and various district-level socio-demographic characteristics variables.

Objective accessibility was assessed based on the existing EV chargers in Hong Kong. A total of 2,503 publicly accessible EV chargers were characterized as standard, medium, quick, and Tesla based on information that was current as of September 2019 (see Appendix Table A1 for details). Their addresses were geocoded and input into ArcGIS for spatial analysis.

3.3 Measuring accessibility

This study operationalized objective accessibility as the total number of EV chargers accessible within a given spatial unit, which is essentially a cumulative accessibility measure (Geurs & Van Wee, 2004; Pirie, 1979). Describing charging demand in terms of the number of quick, standard, medium, and Tesla EV chargers (including Tesla quick and Tesla medium chargers) in each spatial unit, EV accessibility was defined as the number of different types of EV chargers within a certain walking distance. This was estimated as the shortest network-based distance within 5, 10, and 15 minutes of a search radius from centroids of tertiary planning units (TPUs) using the built-in network analysis module of ArcGIS. Travel time was estimated based on an average walking speed of 4.8 km per hour. We used the following formula to calculate the accessibility (T) of a specific type of charger (Q) within a certain walking distance (W) for each TPU ***j***:

$$T_j^{W,Q} = \sum C_k^{Q} L \tag{1}$$

Where $T_j^{W,Q}$ is the total charging opportunities available to TPU *j;* C_k^Q denotes charger *k* of a particular charging type *Q* (i.e., quick, standard, medium and Tesla); and *L* is a binary variable with a value of 1 if charger *k* is within a certain walking distance *W* (i.e., 5, 10, and 15 minutes) and a value of 0 otherwise.

Finally, population-weighted district-level accessibility was calculated by aggregating the TPU-level accessibility, $T_j^{W,Q}$ at the district level, weighted according to the respective TPU's population share of the corresponding district. Thus, objective district-level EV accessibility could be expressed as:

$$D_i^{W,Q} = \frac{\sum_1^J T_j^{W,Q} * P_j}{\sum P_j} \quad (2)$$

where $D_i^{W,Q}$ indicates the EV accessibility of a specific charger type (Q) of district *i* for a particular search radius W; $T_j^{W,Q}$ represents the accessibility of TPU *j* in district *i*; P_j denotes the population of TPU *j*; and *J* denotes the total number of TPU units in a district.

Subjective accessibility was divided into perceptive and prospective accessibility. Perceived accessibility refers to respondents' perceptions of the current EV charger situation, and prospective accessibility describes a variation of subjective accessibility focused on respondent anticipation of the future scenario. Various measurements have been developed to quantify traveler perceptions of accessibility (Lattman et al., 2016b; Ryan et al., 2016; Scott et al., 2007). Table 1 summarizes the scalar items used to measure subjective accessibility, which were built upon those previous approaches. Perceptions of the availability and ease of finding charging stations were combined to represent the perceived accessibility parameter. Prospective accessibility is measured by one question in the survey concerning consumers' view of the ease of charging in the next five years.

Table 1. Measurement of perceived accessibility and prospective accessibility

Perceived accessibility
Charging at own premises is cumbersome.
Charging at public charging stations is cumbersome.
I do not have the patience to wait for the car to charge.
There are too few charging stations in Hong Kong.
Charging stations are hard to find.
It is possible to charge an EV when parking at home.
Prospective accessibility
I expect that there will be more public charging facilities in the next five years.

3.4 Factor analysis and ordered logistic model

Given that several survey questions concerned similar items, before conducting the ordered logistic model, factor analyses (method: principal factors) were performed to reduce the number of variables and streamline our models. This is supported by the Cronbach's alpha results, which suggest satisfactory reliability statistics. An exploratory factor analysis was conducted to examine the eigenvalues and the factor loadings before establishing a criterion for the eigenvalue (e.g., 1) to decide how many factors would be retained. The six perceived accessibility items shown in Table 1 were ultimately entered into the factor analysis.

Another factor analysis was based on two range anxiety items: "A typical electric car does not have enough driving range for my daily driving needs" and "A typical electric car does not have enough driving range for my occasional driving needs."

For modeling, the dependent variable was a respondent's intention to buy an EV as their next car. As the literature review made apparent, many factors affect EV adoption decisions. When selecting explanatory variables, we included our key variables (i.e., objective, perceived, and prospective accessibility) and three important variables with policy implications: range anxiety, environmental consciousness (whether the person belongs to an environmental group), and prior experience with EVs (as a driver or passenger). We controlled for each participant's personal, household, and residential and workplace districts characteristics. [1]

We adopted an ordered logistic model because our dependent variable is an ordered variable (ranging from 1 to 7) indicating an individual's intention. Following the notation in Greene (2008), we have

$$y^* = \boldsymbol{x}'\boldsymbol{\beta} + \varepsilon \tag{3}$$

where x refers to the explanatory variables and ε is assumed to be normally distributed and follow $N \sim (0,1)$. The probabilities are as follows:

$$\begin{aligned}
&Prob\ (y = 1\ |\boldsymbol{x}) = \Phi(-\boldsymbol{x}'\boldsymbol{\beta}),\\
&Prob\ (y = 2\ |\boldsymbol{x}) = \Phi(\mu_1 - \boldsymbol{x}'\boldsymbol{\beta}) - \Phi(-\boldsymbol{x}'\boldsymbol{\beta}),\\
&Prob\ (y = 3\ |\boldsymbol{x}) = \Phi(\mu_2 - \boldsymbol{x}'\boldsymbol{\beta}) - \Phi(\mu_1 - \boldsymbol{x}'\boldsymbol{\beta}),\\
&\vdots\\
&Prob\ (y = 7\ |\boldsymbol{x}) = 1 - \Phi(\mu_6 - \boldsymbol{x}'\boldsymbol{\beta}).
\end{aligned}$$

We ran two models: one for EV owners (Model 1) and one for non-EV owners (Model 2). The sample was separated into two subgroups to acknowledge the different characteristics, behaviors, and preferences of EV owners and non-EV owners (Axsen et al., 2016; Haustein & Jensen, 2018; Peters et al., 2011) and to reveal potentially different influential factors, such as the variable of "(prior) EV experience" for non-EV owners, which a Nordic study revealed to be a significant influencer (Thøgersen & Ebsen, 2019). Both factor analysis and ordered logistic regression were conducted in STATA 16.

4 Descriptive analysis

Table 2 summarizes the descriptive statistics for our survey sample of licensed drivers in Hong Kong. A comparison of the survey sample with the Hong Kong adult population is provided in Appendix Table A2. Due to recruiting only licensed drivers, the demographic characteristics of the sample differed slightly from the overall Hong Kong population, as expected. Male respondents constituted a majority of the sample, and we collected a younger and better-educated group of citizens (only one-quarter of the general population had received university education by 2016) (Census Statistics Department, 2018). Meanwhile, considering the median monthly wage in Hong Kong ($17,500 in 2018) (Census Statistics Department, 2019), the survey sample enjoyed better economic welfare than the general population. Within the sample, more EV owners than non-EV owners were male and held a postgraduate degree. EV owners were also twice as likely as non-EV owners to run their own business. The monthly income of EV owners was also substantially higher than that of other respondents. This was especially notable for the highest income group: half of the EV owners reported earning HK$40,000 or more compared to 25% of non-EV owners. In terms of household characteristics, average car ownership in the EV owner group was 1.267, suggesting that some EV households owned two or more vehicles. That figure was only 0.532 for non-EV owners.

In terms of driving range concerns, EV owners tended to give slightly stronger negative evaluations of driving range and have higher expectations of future performance. Surprisingly, a similar proportion

[1] Although all these variables are potential explanatory and control variables, not all were retained in the final models. In particular, due to the estimation procedure adopted (i.e., stepwise, forward selection at 10% level), no workplace district variables were retained in the final models.

(roughly 15%) of EV owners and non-EV owners had joined environmental groups, indicating a generally high level of environmental consciousness in Hong Kong.

In terms of objective accessibility, we chose to include the set of objective accessibility at 5 minutes walking distance based on best model performance (Appendix Table A3 provides more detail about the performance indicators for the models using different sets of objective accessibility variables based on different walking distances). Although EV owners were exposed to more highly accessible quick and medium chargers, the same group had considerably less access to standard chargers and Tesla chargers. Perceived and prospective accessibility indicators are represented by the evaluation statements in **Table 2**. Scores for perceived accessibility variables were generally similar between the two groups, except that EV owners were more likely to recognize an insufficiency of chargers in Hong Kong.

Table 2. Statistical summary of main variables

	EV owners (N=238)			Non-EV owners (N=744)		
	Mean or percentage	Min	Max	Mean or percentage	Min	Max
DEPENDENT VARIABLE						
Intention to buy an EV as next car	5.580	2	7	4.517	1	7
EXPLANATORY VARIABLES						
Accessibility						
Objective accessibility (population-weighted)						
Accessibility of standard chargers within 5 minutes of walking distance (at district level)	0.873	0.000	6.880	0.890	0.000	6.880
Accessibility of medium chargers within 5 minutes of walking distance (at district level)	0.844	0.000	5.181	0.841	0.000	5.181
Accessibility of quick chargers within 5 minutes of walking distance (at district level)	0.255	0.000	1.291	0.224	0.000	1.291
Accessibility of Tesla chargers within 5 minutes of walking distance (at district level)	0.350	0.000	6.676	0.396	0.000	6.676
Perceived accessibility *(a scale of 1 to 7)*						
Charging at own premises is cumbersome	4.874	1	7	5.073	1	7
Charging at public charging stations is cumbersome	5.046	1	7	4.958	1	7
I do not have the patience to wait for the car to charge	3.937	1	7	4.397	1	7
There are too few charging stations in Hong Kong	5.874	1	7	5.495	1	7
Charging stations are hard to find	5.231	1	7	5.315	1	7
It is possible to charge an EV when parking at home	4.193	1	7	3.922	1	7
Prospective accessibility *(a scale of 1 to 7)*						
I expect that there will be more public charging facilities in the next five years	5.332	1	7	5.309	1	7
Driving range concerns *(a scale of 1 to 7)*						
A typical electric car does not have enough driving range for my daily driving needs.	3.861	1	7	3.844	1	7
A typical electric car does not have enough driving range for my occasional driving needs.	3.966	1	7	3.917	1	7
Prospective driving range *(a scale of 1 to 7)*						
I expect the range of electric cars will be significantly improved over the next five years.	5.697	2	7	5.308	1	7

	EV owners (N=238)			**Non-EV owners** (N=744)		
	Mean or percentage	Min	Max	Mean or percentage	Min	Max
Environmental consciousness						
Environmental group member	15.13%			15.99%		
Prior experience						
EV experience (as driver or passenger)	100%			64.06%		
Personal characteristics						
Female	23.11%			38.84%		
Ages 18 to 34	35.04%			37.15%		
Ages 35 to 44	33.76%			34.19%		
Ages 45 or above	31.20%			28.67%		
Below university	23.11%			33.33%		
Bachelor degree	50.42%			48.39%		
Postgraduate degree	26.47%			18.28%		
Single (never married)	34.47%			37.01%		
Married	63.40%			60.57%		
Other marital status	2.13%			2.42%		
Employed	82.28%			89.10%		
Self-employed	14.77%			7.27%		
Other employment status	2.95%			3.63%		
Income below HK$25,000	21.37%			41.57%		
Income between HK$25,000–40,000	28.63%			33.06%		
Income above HK$40,000	50.00%			25.37%		
Household characteristics						
Number of cars in household	1.267	1	3	0.532	0	3
Household size	3.462	1	6	3.157	1	6
Property owner (with no outstanding mortgage)	31.36%			32.39%		
Property owner (with outstanding mortgage)	43.64%			38.98%		
Tenant	23.73%			27.02%		
Other tenure status	1.27%			1.61%		

Note: There were 982 respondents of which 238 were EV-owners and 744 were non-EV owners. These statistics summarize the observations with valid values for respective variables. Location information (districts of residence and workplace) collected in the survey was also used to derive district characteristics (socio-demographic variables) of the residential and workplace districts, as mentioned in Section 3.2.

5 Results

5.1 Factor analysis

Table 3 shows the factor analysis results for the six perceived accessibility variables and two driving range variables. When selecting the number of factors to be retained, we set a minimum eigenvalue of 1. For the perceived accessibility variables, only one factor, Factor 1 (f_1), had an eigenvalue above 1 (eigenvalue = 2.7260). For the driving range variables, again only one factor, Factor 2 (f_2), was selected (eigenvalue

= 1.4932). Overall, the factor loadings indicate that variables c1, c2, c5, and c6 most contributed to perceived accessibility, with p7 and p8 contributing equally to consumer concerns about driving range. Both α values corresponding to f_1 and f_2 exceeded 0.7, representing acceptable reliability. In view of the statistics reported in Table 3, for easier interpretation, we can label Factor 1 f_1) "perceived poor accessibility to EV charging facilities" and Factor 2 (f_2) "inadequate driving range." This possible interpretation of the two factors anticipates both having a negative effect on EV adoption intention.

Table 3. Factor loadings, variances and scoring coefficients (method = regression; based on varimax rotated factors)

Variable	Factor 1 (f_1)			Factor 2 (f_2)		
	Factor loadings	Unique variances	Scoring coefficients	Factor loadings	Unique variances	Scoring coefficients
Charging at own premises is cumbersome. (c1)	0.7350	0.4598	0.2472			
Charging at public charging stations is cumbersome. (c2)	0.7942	0.3692	0.2784			
I do not have the patience to wait for the car to charge. (c4)	0.5717	0.6732	0.1172			
There are too few charging stations in Hong Kong. (c5)	0.7314	0.4651	0.2130			
Charging stations are hard to find. (c6)	0.7784	0.3941	0.2756			
It is possible to charge an EV when parking at home. (c7)	-0.2955	0.9127	-0.0504			
A typical electric car does not have enough driving range for my daily driving needs. (p7)				0.8641	0.2534	0.4747
A typical electric car does not have enough driving range for my occasional driving needs. (p8)				0.8641	0.2534	0.4747

Note: N = 930; α_{f1} = 0.799; α_{f2} = 0.901

5.2 Estimation results for ordered logistic models

We estimated participant intention to buy an EV as their next vehicle using ordered logistic models for EV owners and non-EV owners. The distributions of their purchase intentions (Table 4) show that EV owners highly favored EVs as their next vehicle choice, with a more even distribution across the 7 categories (except for the lowest category) observed for non-EV owners. Too few observations in any category will raise questions about model validity and parameter estimability. Moreover, a strong assumption of the ordered logistic model is the proportional odds assumption (also known as the parallel lines assumption), which indicates that all explanatory variable coefficients are identical across all outcome categories. This can be tested by the Brant test (Brant, 1990). Having more categories in an ordered logistic model is essentially associated with higher demand of the "proportional odds," which means that the model would be more likely to violate the parallel regression assumption. Therefore, we merged some of the categories with relatively small numbers of observations such that each category would have sufficient observations (e.g., contain at least 40 samples and account for at least 10% of the subgroup population) and the final models would "pass" the Brant test (i.e., the parallel lines assumptions would not be violated). Consequently, in reference to Section 3.4, the cut-off values in the ordered logistic models (μ_i) for EV owners and for non-EV owners would be two and four.

Table 4. Regrouping observations by EV purchase intention

EV owners				Non-EV owners			
Original category	Frequency	%	New category for modeling$^{\zeta}$	Original category	Frequency	%	New category for modeling$^{\zeta}$
1	0	0	5	1	28	3.92	3
2	3	1.39		2	39	5.46	
3	4	1.85		3	70	9.80	
4	30	13.89		4	181	25.35	4
5	76	35.19		5	224	31.37	5
6	41	18.98	6	6	127	17.79	6
7	62	28.70	7	7	45	6.30	

Note: ζ : the value of the new categories would not affect the estimation results.

Given the large number of potential explanatory variables, we chose the stepwise estimation approach, with variables statistically significant at the 10% level entering the model. This also avoided the risk of two highly correlated variables being included in the model. Additionally, we conducted a series of correlation analyses (which include correlation among the explanatory variables included in the final models, with particular attention paid to the correlations between accessibility measures and driving range and between objective and subjective accessibilities) that revealed no major multi-collinearity issue.

The estimation results from the ordered logistic models are summarized in Table 5. After removing observations with missing information (e.g., location information for residence/workplace district), the final samples included 213 EV owners (Model 1) and 710 non-EV owners (Model 2). One or more accessibility variable (our main variables of interest) was statistically significant in both models.

Objective accessibility was statistically significant in both models, as expected, given easier access to public charging facilities is often considered critical to people's acceptance of or willingness-to-pay for an EV. For the objective (population-weighted) accessibility measures, we tested models 1 and 2 (Model 1 for EV owners; Model 2 for non-EV owners) for the objective variables (standard, medium, quick, and Tesla chargers) within a 5-minute, 10-minute, and 15-minute (walking distance) search radii. In both models, the measures always performed better at a 5-minutes search radius than at a 10- or 15-minute search radius (see Appendix Table A3 for more details about the model performance indicators). Therefore, we have reported the estimation results for the 5-minute search radius. This implies that respondents are more sensitive to accessibility within 5 minutes than accessibility over a larger area. While this search radius may seem small, it potentially reflects Hong Kong's high density and the willingness-to-walk of residents in the city. Moreover, among the tested objective variables measured at a 5-minute search radius in residential and workplace districts, only 5-minute standard chargers in the residential district entered the stepwise selection.

Notably, only accessibility of Tesla chargers had a statistically significant positive effect on the EV purchase intention of EV owners, with accessibility to standard chargers proving significantly positive for non-EV owners' purchase intention. This result is consistent with the Tesla-dominated market in Hong Kong, explaining why most existing EV drivers pay extra attention to the accessibility of Tesla chargers. For non-EV owners, access to numerous standard chargers is most appealing. The visual analysis (see Appendix Figure A1) reveals that the type of standard chargers within a 5-minute walk distinguishes its spatial distribution from that of the other three charger types, with two additional areas of concentration located around Tai Po and Kwun Tong, two of Hong Kong's main residential districts.

This could partially explain the importance of accessible standard charging stations for the large market of non-EV owners. Therefore, the findings for objective accessibility have three important implications. First, charging facilities near one's home (i.e., within a 5-minute walk) are perceived as more important than charging facilities near the workplace because the objective accessibility variables are statistically significant for the residential district. Second, the acceptable distance to a public EV charger in our study context (i.e., Hong Kong) is small, suggesting that densification of charging infrastructure is critical. Third, the number of standard chargers matters more than the number of other types of chargers for non-EV owners, and the number of Tesla chargers is more important for EV owners.

Regarding perceived accessibility, the perceived accessibility derived from factor analysis, f_1 (which can be interpreted as "perceived poor accessibility of EV charging facilities") is not statistically significant for existing EV owners (Model 1), likely because they are already embedded in the EV ecosystem and are well aware of the current spatial distribution of EV chargers (through personal experience, EV charger apps or websites). This indicates that this variable will not substantially affect their intention to buy an EV as their next vehicle. However, this factor is statistically significant for non-EV owners (Model 2), and it is negatively associated with their purchase intention, suggesting that transitioning from an ICE to an EV demands a good charging network and a satisfactory level of perceived accessibility.

Findings for prospective accessibility basically align with the findings for objective and perceived accessibility. This variable was also only statistically significant in the non-EV owner model, likely for reasons similar to those explaining perceived accessibility. The future deployment of publicly available EV charging facilities can critically attract potential car owners to the EV market. This has strong planning implications for both the government and the EV industry: recognizing that charging infrastructure may not be as easily accessible as petrol stations, transport planners should plan ahead to improve the spatial deployment of EV facilities.

Beyond the accessibility measures, this study reveals three other interesting factors. The first concerns whether a respondent belongs to an environmental group. This was included in the questionnaire because we expected that those interested in EVs might be attracted by the zero roadside emissions and limited noise pollution associated with EVs. Unsurprisingly, this variable was highly significant. The second factor of interest was technical concerns related to EV driving range. Two variables relate to this. The first variable was derived from our factor analysis, f_2 ("inadequate driving range") and negatively impacted the intention of EV owners to choose an EV as their next vehicle. The second related to holding the position "I expect the range of electric cars will be significantly improved over the next five years," which demonstrated that a stronger belief in the future driving range of EVs positive impacts EV purchase intention among both EV owners and non-EV owners. The third factor of interest was whether non-EV owners had any prior experience as an EV driver or passenger. The highly significant results show that those with experience with EVs are more likely to adopt an EV, echoing the findings of a recent study in Denmark (Thøgersen & Ebsen, 2019).

Regarding personal characteristics, gender had a significant effect in Model 1: current female EV owners were less likely to purchase an EV as their next vehicle than their male counterparts. Age and education level were also statistically significant in Model 1. For example, EV owners aged 35–44 and 45 or older reported finding EVs more acceptable than younger groups, and individuals holding a university degree were also more likely to purchase an EV.

Regarding household characteristics, among non-EV owners (Model 2), homeowners (with an outstanding mortgage) were more likely to demonstrate intention to adopt an EV. Meanwhile, using district-level census population data, we tested several variables for each respondent's residential district: the percentage of single persons, the median age, the percentage of postgraduate degree holders, and the median household income. Only the percentage of postgraduate degree holders had a significant effect and only in Model 1, where the effect was negative.

Table 5. Estimation results

	Model 1 (EV owners)			Model 2 (Non-EV owners)		
Variable	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value
Accessibility						
Objective accessibility						
(Population-weighted) Accessibility of tesla chargers within a 5-minute walk of residence (at district level)	.4715***	.1752	0.007	--	--	--
(Population-weighted) Accessibility of standard chargers within a 5-minute walk of residence (at district level)	--	--	--	.1418***	.0420	0.001
Perceived accessibility						
f_1 ("perceived poor accessibility of EV charging facilities")	--	--	--	-.2403***	.0860	0.005
Prospective accessibility *(a scale of 1 to 7)*						
I expect that there will be more public charging facilities in the next five years.	--	--	--	.3329***	.0806	0.000
Driving range concerns						
f_2 ("inadequate driving range")	-.4835***	.1394	0.001	--	--	--
Prospective driving range *(a scale of 1 to 7)*						
I expect the range of electric cars will be significantly improved over the next five years.	.3573***	.1333	0.007	.2729***	.0868	0.002
Environmental consciousness						
Environmental group member	1.2137***	.3980	0.002	1.4618***	.2342	0.000
Prior experience (for non-EV owners)						
EV experience (as a driver or passenger)	n.a.	n.a.	n.a.	1.0282***	.1569	0.000
Personal characteristics						
Female	-1.2920***	.3619	0.000	--	--	--
Aged 45 or above	1.5703***	.3719	0.000	--	--	--
Aged between 35 and 44	.6918**	.3527	0.050	--	--	--
Bachelor degree	.6569**	.3103	0.034	--	.--	.--
Household characteristics						
Property owner (with outstanding mortgage)	--	--	--	.3103**	.1476	0.036
District characteristics (residence or workplace district)						
Percentage of postgraduate degree holders (of residence district)	-.0783***	.0273	0.004	--	--	--
Cut-off values *(μ_i)*						
μ_1	n.a.	n.a		n.a.	n.a	
μ_2	n.a.	n.a		n.a.	n.a	
μ_3	n.a	n.a		2.4967	.3986	
μ_4	n.a	n.a		3.9910	.4129	
μ_5	.4974	1.2095		5.8183	.4432	
μ_6	1.6114	1.2171		n.a.	n.a	
Model summary						
N	213			710		
Log likelihood	-180.3154			-842.3346		
Prob. > Chi2	.0000			0.0000		
Pseudo R2	.1635			0.1345		

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.3 Qualitative analysis

At the end of the questionnaire survey, an open-ended question was asked to understand which developments might boost respondents' EV purchase intention. As expected, improved charger accessibility was a commonly articulated issue, with 399 of the 720 valid comments indicating that improved charger availability would increase their adoption desire. Among those who mentioned charger availability, ten percent specified convenient access to chargers, which corresponds to the model result concerning the significant contribution of short-distance access (within 5 minutes) to charging facilities. Some respondents demonstrated high sensitivity to ease of access:

> Parking locations [with chargers] need to be closer to mall entrance/exits and chargeable. (Respondent #601: male, 25–34, licensed driver)

In terms of charging venue, home charging has always been favored by EV owners and potential purchasers, leading to calls for the government to facilitate charger installation in housing estates. Comments from existing EV owners echo the quantitative evidence, demonstrating a significant preference for charger accessibility in home rather than work districts.

Currently, installing EV chargers in residential buildings or estates in Hong Kong is costly and cumbersome. Application proposals require consent from the owners' corporation or property management company. Meanwhile, power providers require applications for electricity supply that specify the estimated loading, wiring diagram and charger position (Hong Kong Electric, 2018). Given the potential disputes with incorporated owners pertaining to the limited power reserved for alternative electricity uses and the insufficient space available at standard parking lots, installing a private charger in one's parking bay is not a common practice. These physical constraints and administrative obstacles hinder perceived accessibility (f_1) via the item, 'It is possible to charge an EV when parking at home'. Multiple EV owners demanded government intervention to enable home charging:

> Home charging [is the] biggest issue for everyone. BMO [Building Management Office] acts very difficult despite assurances from the electric company… (Respondent #60: male, 25–34, EV owner)

> [In terms of] installing charging facilities in residential buildings, the government should assist [by] supervising the approval [because] owners' corporations usually choose to reject the proposal due to insufficient knowledge. (Respondent #45: male, 45–54, EV owner)

> Legislate that all existing and new residential estates must [enable] EV chargers to be installed easily and at a reasonable cost for both property owners and renters. (Respondent #65: male, 45–54, EV owner)

Apart from reservations about charger installation, the reliable service of accessible chargers represents another primary concern of EV pioneers. EV owners criticized the behavior of EV drivers leaving cars parked after charging is complete and ICE vehicles parking in such a way there is no access to EV charging points. However, potential EV purchasers were also aware of this situation:

> [A] policy is needed against long-time occupation of charging facilities. (Respondent #907: female, 24 or younger, licensed driver)

> Even if there are more public chargers, my intention will [increase] only if drivers comply with [the] rules. If people dominantly occupy [the charging slots], EVs will not be popularized. (Respondent #502: female, 45–54, ICE vehicle owner)

As noted by Lotfi and Koohsari (2009), subjective and objective assessments of accessibility can differ fundamentally. Even assuming that EV drivers are well-informed of the physical availability of charging points, frustrating experiences could still impair accessibility to charging infrastructure in a subjective sense, such that previous unsuccessful charging experiences could modify subjective charger accessibility. In response to the prevalence of these abuses, drivers propose fining undesirable behaviors and establishing prioritized or exclusive parking spaces for EVs. By rectifying obstructive practices, user confidence in the accessibility of service points could be restored, improving the subjective accessibility of charging facilities.

Overall, in terms of factors that impact EV acceptance, the feedback aligned with the findings of the quantitative models. Demands for infrastructural support and financial incentives from the government were common. The significance of governmental action regarding subjective and prospective accessibility is evident in how citizens anticipate accelerated infrastructure accessibility upon a policy announcement, even when objective accessibility does not increase. This qualitative evidence reinforces the idea that subjective expectations of charger accessibility, a novel feature introduced in this paper, can represent a valid motivator for consumers to increase their overall EV purchase intention.

6 Conclusion and policy recommendations

Accessibility is a key factor in urban planning, impacting the ease with which people can reach activity opportunities in a city or a region. In the era of e-mobility, accessibility measures should consider opportunities that arise alongside new transport modes (such as EVs), especially key issues related to adoption and usage. Accordingly, this paper has measured access to public charging facilities; although this variable has been shown to impact EV adoption rates, no empirical study has demonstrated how much accessibility affects individual adoption. This is especially important in Hong Kong, where home-based charging is challenging, making accessible public chargers critical for EV adoption intention. Additionally, despite the well-documented theoretical and empirical explorations of objective measurements, subjective accessibility has yet to receive much attention in the extant literature. To fill this gap, we collected data regarding the intention of respondents to choose an EV as their next vehicle, examining the impact of objective, perceived, and prospective accessibility of public charging stations on that purchase intention.

Our contribution to the literature on accessibility extends beyond the new mobility mode by also considering measures of accessibility other than the traditional, objective measure of proximity. Our findings demonstrate that the perceived and prospective accessibility of public chargers can significantly impact the intention of non-EV owners to buy an EV. We have also observed that most modeled factors are significant for one group but not the other, suggesting that EV owners and non-EV owners have different levels of knowledge about and acceptance of EVs. Therefore, keeping existing EV owners in the market and promoting e-mobility among non-EV owners require different planning strategies.

While this study has focused on accessibility measures, we have also revealed that vehicle driving range, environmental consciousness and prior EV experience critically contribute to purchase intention. An individual perceiving EVs to have ample driving range, either currently or in the future, is more likely to adopt, as is an individual belonging to an environmental group and an individual with experience driving an EV or riding in an EV as a passenger.

The research findings enable several policy recommendations. First, the significance of certain objective measures of accessibility, namely, the number of standard and Tesla chargers publicly available within a five-minute walk of an individuals' residential district, suggests a demand for more public charging facilities. We emphasize the very short acceptable walking distance to a charging station, a particular challenge for compact cities such as Hong Kong. To this end, only dramatically increasing the number and density of public charging stations can motivate potential car owners to buy an EV and retain the adoption momentum among EV pioneers. Transport planners require better spatial planning of public charging infrastructure that can optimize the coverage of demand points under a certain budget while also considering contextualized spatial and institutional constraints (He et al., 2016; He et al., 2022).

Second, perceived accessibility was found to be highly significant for non-EV owners. Although some of those findings re-iterated the objective accessibility findings, others revealed different aspects of accessibility, including the convenience of charging and ease of locating charging infrastructure. This extends beyond the number of public chargers required and calls attention to introduce measures to inform people where these chargers are located and how they can locate them more easily. More importantly, the convenience of charging can be improved by allowing EV users to learn when public chargers are to become available and learn whether they can make reservations. This system could help to popularize EVs.

Third, prospective accessibility was observed to greatly impact the adoption intention of non-EV owners. Respondents demonstrated a moderate-to-high expectation (a score of 5.315) that more public charging facilities would be available in the next five years, boosting their interest in and enthusiasm for EVs. Consequently, the government and the EV industry should work towards this goal to realize the expected near-future densification of public chargers and enable more potential users to become EV users. Publicizing a pro-EV policy work plan could represent something beyond an administrative earmark, with the qualitative analysis revealing that adoption intention is enhanced by information about a prospective improvement to accessibility.

Fourth, the findings for perceived and prospective accessibility suggest that we can design programs that promote environmental consciousness and educate people about the environmental impacts of driving. This is reinforced by the observation that environmentalists (as indicated by involvement in environmental concern groups) have a strong tendency to purchase an EV regardless of their current EV ownership. As part of such initiatives, people should be exposed to more opportunities to experience EVs, increasing awareness of the advantages of this new mobility option and elevating confidence in driving EVs.

Fifth, targeting the flaws in the EV ecosystem – such as by taking measures to prevent charging slot abuse – represents an area of improvement for the government. Tesla has already initiated an idling fee of HK$7.80 per minute at Tesla Superchargers when the station is fully occupied (Tesla, 2019). Making this approach public policy could increase the confidence of existing EV owners to continue their usage and lift the psychological reservation of interested non-EV owners. Additionally, the inefficient use of charging facilities urges governments and EV companies to rethink and redesign charging stations to be more than just spatial reflections. This echoes the discussion of parking as a land use that recognizes parking lots as a common but neglected place with real and massive negative environmental, social, and spatial ramifications (Ben-Joseph, 2012; Feitelson & Rotem, 2004). That is, charging stations could also provide an unprecedented canvas for urban transformations in service of various social, cultural, and environmental activities. Accordingly, this study argues that improved utilization of charging stations deserves attention from the land-use perspective.

Sixth, although this paper has emphasized the proactive enhancement of charger accessibility, given the critical impact of driving range factors on purchase intentions, attention should also be given to increasing the battery capacity of EVs. Although this factor has less influence on drivers in high-density cities because the range of most EV models already supports daily use, a larger battery volume would alleviate the range anxiety of EV drivers, and the longer charging interval would provide a more comfortable charger search time, both of which would contribute to a more pleasant driving experience.

This research has several limitations. First, although we measured objective accessibility at the TPU level, this had to be aggregated at the district level because we only knew the residential and workplace locations of respondents at the district level. Thus, this measurement may not have captured the nuanced differences in objective accessibility between individuals. Future studies should aim to obtain home and workplace locations at a more fine-grained level. Second, besides working trips, leisure trips may also importantly impact user EV adoption intention. Thus, a more comprehensive study investigating the effects of trip purposes on EV adoption intention would be worthwhile. Finally, participant recruitment did not strictly follow Hong Kong's socio-demographic profile. We only recruited individuals with a driver's license and we aimed to achieve a sample featuring 20–25% EV owners, potentially overrepresenting a certain social stratum defined by higher incomes, higher rates of homeownership and higher rates of marriage. Therefore, the forecast results should be interpreted with caution, and a systematic study of the allocation of public charging stations should be conducted to offer more practical transport planning recommendations to the government.

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Appendix

Appendix available as a supplemental file at https://jtlu.org/index.php/jtlu/article/view/2113.

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