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Who are less likely to vote for a low emission charging zone? Attitudes and adoption of hybrid and electric vehicles

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Abstract

Based on data derived from a self-reported questionnaire survey (n=595), the current study was carried out to (a) determine the extent to which residents support a Low Emission Charging Zone (LECZ) via a hypothetical referendum voting, (b) examine the relationship between intention to adopt Hybrid and Electric Vehicles (HEVs) by voting for/against LECZ through employing the Theory of Planned Behaviour (TPB), and (c) investigate public attitudes towards the proposed system. The results indicated that around two-thirds of the participants voted against the LECZ scheme, and that latent psychological factors had a stronger impact on voting against the LECZ than observed variables. The results also revealed that people would be more likely to adopt and less likely to oppose the LECZ if the price, maintenance, and repair of HEVs were affordable. Regarding public attitudes towards the proposed system, distrust in government concerning the use of LECZ-derived revenues was noticeably related to the LECZ rejection. In the light of the findings, some policy and planning implications are recommended.

Keywords: Low Emission Charging Zone, hybrid and electric vehicles, attitudes, referendum voting, Road pricing

1. Introduction

It is widely reported that the increasing use of gasoline/diesel cars in urban road transport is the cause of traffic congestion, air pollution and health risks such as respiratory diseases and ventricular hypertrophy (Krzyżanowski et al., 2005; Kopnina, 2016). Most megacities across the globe are struggling with traffic-related air pollutants such as carbon emissions, ozone (O_3), particulate matter (PM), and nitrogen dioxide (NO_2) (WHO, 2006). According to the statistics published by World Health Organization (WHO) in 2016, as stated by Heger and Sarraf (2018), the annual outdoor level of coarse PM (PM_{10}) was above its recommended threshold of 20 $\mu g/m^3$ in some megacities in Asia (e.g. Karachi, Delhi, Beijing, Tehran, Tokyo), Europe (e.g. Moscow), and Africa (i.e. Cairo). For instance, as reported by World Bank Data, mobile sources, such as gasoline/diesel cars, make the most significant contribution to the ambient PM air pollution in Tehran. It is also forecasted that outdoor fine PM ($PM_{2.5}$) accounts for the death of around 4000 citizens in Tehran annually (Shahbazi et al., 2019; Heger and Sarraf, 2018).

In order to alleviate traffic-related air pollution, policymakers have taken measures to (a) reduce the use of gasoline/diesel car in cities, especially in central business districts using Congestion Charging (CC) schemes, (b) restrict the commute of highly polluting vehicles to specified zones by launching Low Emission Zone (LEZ), and (c) promote cleaner productions such as alternative-fuel vehicles and Hybrid and Electric Vehicles (HEVs). One of the most challenging policies is congestion charging (CC), which has been implemented with conflicting outcomes in several developed and developing cities (Börjesson and Kristoffersson, 2018; Wang et al., 2017). Unlike the CC scheme, the main purpose of LEZ system is to alleviate fossil fuel emissions from motor vehicles and promote the use of clean energy vehicles instead of charging fees or imposing penalties (Wang et al., 2017). The acceptability of CC by general public prior to its implementation has been investigated in the literature (Grisolía et al., 2015; Gu et al., 2018), but little is known about the extent to which people support a Low Emission Charging Zone (LECZ). Broadly speaking, an LECZ system imposes stricter rules than CC/LEZ. It is a zone that combines the rules of both CC and LEZ. In other words, to enter an LECZ, citizens not only must meet a minimum standard for their vehicle emissions but also have to charge for congestion based on entry and exit time, i.e. peak and off-peak times. More recently, authorities in London, Milan and Berlin have reported that the integration of CC and LEZ schemes as a package might effectively reduce traffic-related air pollutants compared to other schemes such as sole implementation of CC or LEZ (Plowden, 2015; Wang et al., 2017). In an LECZ scheme, alternative-energy vehicles such as HEVs can also travel free of charge in the zone.

As far as public acceptability is concerned, from a democratic perspective, studies show that holding a referendum is more likely to help build legitimacy and long-term survival of charging policies (Hensher, and Li, 2013; Hysing, 2015; Mehdizadeh and Shariat-Mohaymany, 2020). Therefore, the current study aimed to investigate how different attitudinal variables,

socioeconomic and travel-related factors are related to voting for/against a pro-environmental scheme, which represents an LECZ in a hypothetical referendum situation. The contributions of this paper are as follows. First, we investigated the acceptability of an LECZ in a hypothetical referendum voting. Second, we explored voting support related to a scheme stricter than LEZ/CC in a city where CC and Odd-Even schemes have been implemented for years. In other words, people have experienced benefits and costs of relevant traffic policies in the study area. Direct public participation for conducting schemes in the study area has been overlooked by politicians both in implementation and policy formation stages. Thus, the present study sought to reveal the extent to which citizens support a pollution charging system (i.e. LECZ) through a hypothetical referendum. Third, for the first time, we examined the association of intentions to adopt[1] HEVs, attitudes towards HEVs, social norms pertained to HEVs and perceived behavioural control of HEVs with voting for or against an LECZ system in a hypothetical referendum. To test the structural relationship between abovementioned psychological constructs and the outcome variables, the Theory of Planned Behaviour (TPB) proposed by Ajzen (1991) was applied. Fourth, in addition to psychological factors related to HEVs, public attitudes and perceptions towards an LECZ system, such as mistrust towards the government in revenue allocation, the complexity of the proposed system and fairness were also investigated in voting for/against such an LECZ system. Fifth, we tested all latent psychological variables, including the TPB and attitudes towards LECZ along with observed variables such as socioeconomic and travel-related variables, built environment, and demographic attributes in an inclusive framework using a Hybrid Choice Model (HCM). In an HCM-analysis, as noted by Mehdizadeh et al. (2019b), a modeller can simultaneously consider direct and indirect effects of latent and observed variables in a traditional discrete choice model.

The following sections of this study contain a review of relevant literature and the illustration of the conceptual framework employed in the present study, the methodology, the specification of the model and the results, thorough discussion based on the obtained results, the conclusions along with some policy and planning implications.

2. A review of literature

A large body of research (e.g., Grisolía et al., 2015; Schade and Schlag 2003; Schuitema et al., 2008) has investigated the public acceptability of CC schemes in the policy-making phase before its implementation stages, reporting that socioeconomic variables (income, gender, age), scheme features (period, area, toll price of charging), and attitudinal factors and perceptions (perceived effectiveness of scheme, trust in government, perceived fairness) are correlated with CC acceptability. Previous studies suggest that citizens who are doubtful about the effectiveness of

[1] Regarding HEVs, although we asked people about their "purchase/use" intention of HEVs in the original questionnaire of the study, we have used the words "adopt" and "adoption" instead of "purchase/use" throughout the paper.

the proposed CC policy (Mehdizadeh and Shariat-Mohaymany, 2020; Schade and Schlag, 2003), and those who distrust the government regarding revenue allocation (Mehdizadeh and Shariat-Mohaymany, 2020; Kim et al., 2013), as well as those concerned about fairness of CC (Rentziou et al., 2011) were less likely to accept such a policy. Meanwhile, some studies have also focused on the acceptability of LEZ systems (e.g. Sfendonis et al., 2017). However, studies related to LEZ (e.g. Carslaw and Beevers, 2002; Ellison et al., 2013) mostly examined the extent to which such policies would reduce air pollution after implementation. Ellison et al. (2013) found that PM concentrations in London's LEZ have dropped by 2.46–3.07%.

In most of proposed charging schemes (CC/LEZ) all over the world, clean vehicles (e.g. HEVs), with a carbon dioxide (CO_2) emission of less than 100 g/km, are exempt from paying fees when entering such restricted areas (Wang et al., 2017). Akin to effects of intention to buy and use hybrid and electric vehicles (HEVs), previous research has failed to investigate the link between HEVs adoption and acceptability of either CC/LEZ or stricter schemes such as LECZ. Previous studies have solely examined how the people attitudes, subjective norms, and perceived behavioural control can explain intention to purchase/use HEVs (Chu et al., 2019; Huang and Ge, 2019; Nazari et al., 2019) or investigated other aspects of HEV (He et al., 2017; Yoon et al., 2019). Drawing on the Theory of Planned Behaviour suggested by Ajzen (1991), Huang and Ge, 2019 concluded that favourable attitudes and perceived behaviour control are positively associated with people's intentions to buy electric vehicles in Beijing. However, they found that subjective norms had not effect on buying intention in China (Huang and Ge, 2019).

A closer look at the literature reveals several research gaps. First, the public acceptability of the LECZ scheme (the integration of CC and LEZ system) has never been investigated. Second, previous research on congestion/pollution charging policies have only focused on people who either had not experienced CC scheme or had directly participated in a referendum on the implementation phase of CC schemes. The current study examined the public acceptability of LECZ in Tehran, where local politicians had implemented CC schemes without any referendum (direct public participation). Third, there is little known on how different psychological constructs associated with HEVs adoption could relate to voting for/against pollution charging policy.

3. Conceptual framework and hypotheses

Fig. 1 illustrates the theoretical modelling framework of the study. In this integrated hybrid choice model (HCM), four sets of variables including (1) socioeconomic variables, (2) built environment and travel-related attributes, (3) attitudes towards LECZ system, and (4) the adjusted theory of planned behaviour with respect to HEVs are shown. From a theoretical perspective, it has been shown that attitudes have an important effect on behaviour (Ajzen, 1991). For instance, previous research suggests that attitudes towards CC including trust in government, fairness, complexity, effectiveness and freedom can affect public acceptability of

CC schemes (Schade and Schlag, 2003; Kim et al., 2013). Hence, it is hypothesised that attitudes towards the LECZ system, such as system complexity, LECZ effectiveness and fairness can be negatively or positively related to voting for/against LECZ in a hypothetical referendum (as the outcome behaviour). In line with the theory of planned behaviour (Ajzen, 1991), the interaction of attitudes, subjective norms, perceived behaviour control, and intention to perform a specific behaviour can be related to the outcome behaviour. Therefore, as illustrated in Fig. 1, it is hypothesised that HEVs adoption including structural associations between attitudes towards behaviour, subjective norms, perceived behaviour control, and intention to adopt can be positively linked to voting for the LECZ policy through the theory of planned behaviour. Apart from the psychological factors above, previous research has also revealed that socioeconomic variables are correlated with the acceptance of CC schemes (as a behaviour) (e.g. Jaensirisak et al., 2005) and psychological factors like attitudes (e.g. Kim et al., 2017). Thus, it is hypothesised that socioeconomic variables can exert direct/indirect impact on voting against/for the policy through latent psychological factors, known as mediator variables. Finally, it is assumed that the travel-related and built environment features can also be either positively or negatively associated with voting for/against the LECZ system.

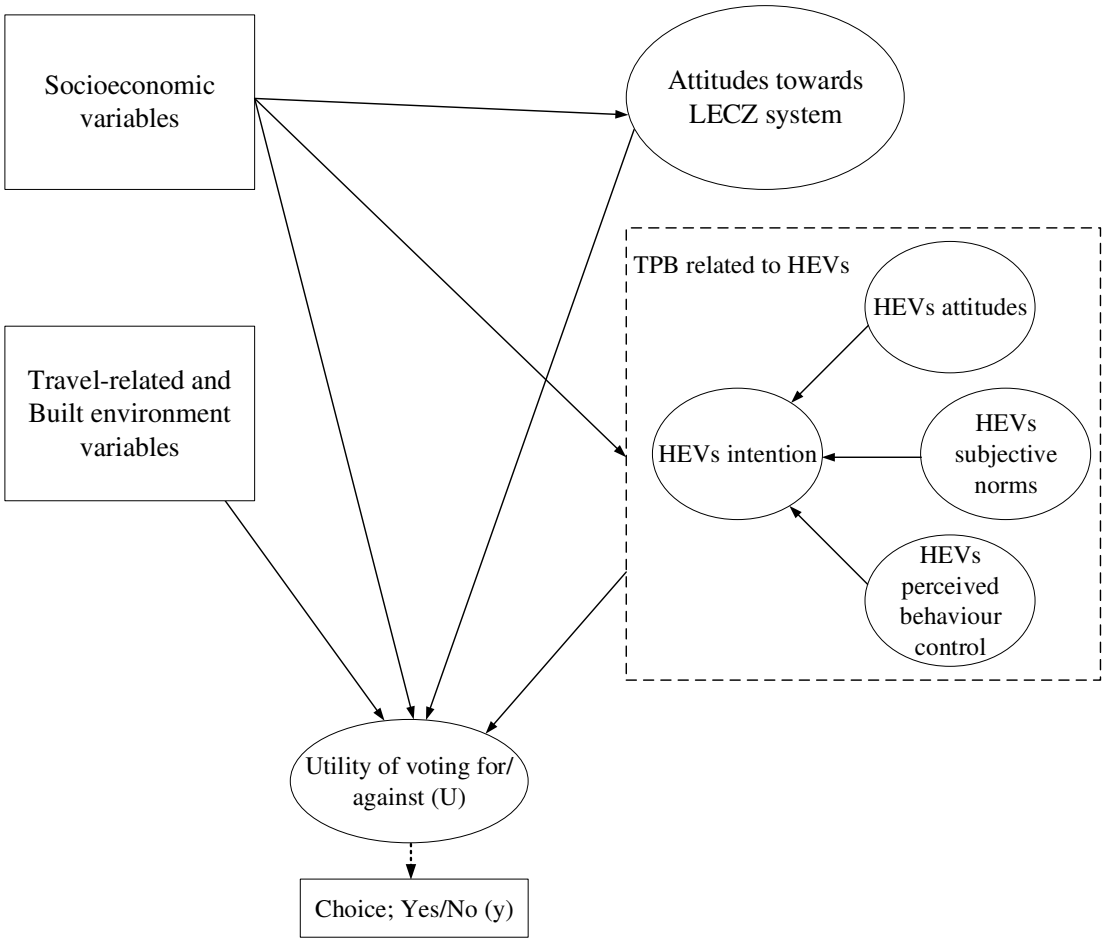


Fig 1. Hypothetical modelling framework

4. Methodology

4.1. The context of the study

This study was conducted in the city of Tehran, Iran. With a population of approximately 8.5 million and an area of 740 km^2, Tehran is situated in northern Iran. This city, as Rafiee et al. (2020) point, is among the most polluted cities in the world. According to the annual report by Tehran Air Quality Control Company (AQCC), Tehran had "160 days characterised with unhealthy air from 3/21/2013 to 3/20/2014" (Shahbazi et al., 2016, p. 218). According to World Bank's data in 2018, a substantial portion (about 70%) of PM emissions in Tehran comes from the vehicles (traffic-related emissions). In Tehran, cars constitute the largest share (80%) of motor vehicle among about 4.24 million registered vehicles (Heger and Sarraf, 2018).

According to Mehdizadeh and Shariat-Mohaymany (2020), to alleviate traffic-related air pollution in Tehran, local policymakers have passed a series of policies and practices, including the development of a bus rapid transit and metro system, expansion of bus lanes, Odd-Even-numbered license plate Zone (OEZ), fuel rationing, and Congestion Charging (CC) zone. As for restricted traffic zones, two main schemes have been in place in the central business district (CBD) of Tehran since 2016. The CC zone, with an area of with 32 km^2, surrounds the first ring of the city, and the second ring, with an area of 74 km^2, is dedicated to the OEZ. Regarding cleaner vehicles, Tehran officials have recently promoted the availability of HEVs by decreasing the import tax from 40% to 4% (Heger and Sarraf, 2018). They also allocated a noticeable charge discount for entering the CC zone to vehicles that meet emission standards.

Despite abovementioned measures, due to the growing rate of car ownership, Tehran had only 19 clean air days (AQI<50) according to air quality index (AQI) in 2018. Hence, policymakers have urged to pass stronger air-quality legislation such as LECZ (integration of CC and LEZ) instead of the OEZ. The current study aims to investigate factors influencing citizens' opinion to vote for/against the LECZ in a hypothetical referendum. Unlike empirical evidence related to most developed cities (Gu et al., 2018), all traffic-related charging policies in Tehran have been introduced without holding any referendum. This can adversely affect public acceptance of these charging schemes. A referendum is likely to contribute to the survival of the scheme. As argued by Hensher and Li (2013) and Mehdizadeh and Shariat-Mohaymany (2020), this can explicitly demonstrate the role of democracy in making significant reforms.

4.2. Procedure and respondents

A cross-sectional self-report questionnaire was designed and distributed among car users in Tehran from February and March of 2019. The data was collected from 22 carwashes and car parking lots from all 22 municipal districts of Tehran. Out of 710 car users, 622 (88%) agreed to participate in the survey. The respondents were informed about the voluntary nature and

anonymity of participation in the survey. The participants were also ensured that their participation would have no impact on the assessment of government and other political agencies. Moreover, a pilot survey was conducted on 50 car drivers in late 2018 to figure out how and to what extent the survey measurement was effective. Based on the results of this pilot survey, we modified the wording of some attitudinal items.

4.3. Measurement of variables

The questionnaire consisted of the following categories: built environment and travel-related attributes, socioeconomic variables, attitudes towards different aspects of the introduced LECZ scheme, psychological dimensions of Ajzen's Theory of Planned Behaviour (TPB) in terms of HEVs adoption, and a question regarding voting for/against the LECZ scheme in a hypothetical referendum.

Data on respondents' socioeconomic attributes, such as age, gender, educational background, job status, income level, car ownership, and household size were gathered in the first section of the questionnaire (see Table 1). We used only three categories to measure age, hypothesising that in such policies (e.g. CC or LECZ), different generations may hold diverse attitudes or perceptions of the government or politicians. In particular, since the last Iranian (political) revolution dates back to 1979, we hypothesised that citizens above 40 years of age are more likely to be loyal to politicians' decision in Iran. For this reason, we defined just a single category for people over the age of 40. Participants were further asked about the perceived walking time from their houses to the nearest public transport station, and the perceived travel time by various modes of transportation from their house to the CBD. The participants were also asked about the number of times they commuted to the CBD based on seven purposes of a trip: shopping, school, work, social events (e.g., visiting friends, going to party), personal affairs (e.g., visiting doctors, banking), entertainment, and others. To investigate whether the respondents vote for/against the proposed LECZ, a hypothetical question was asked, "Assuming that you are about to vote in a referendum on the implementation of the LECZ scheme, would you vote for/against this scheme?" Before asking this question, the proposed LECZ was explained to the respondents to help them understand its details and characteristics. The proposed LECZ scheme was introduced in the manner that local policymakers had submitted the LECZ document to the City Council. As shown in Fig 2, the details of LECZ rules were reported to the respondents. As can be seen, three types of cars, blue (e.g. HEVs), green, and yellow, have to pay certain daily charges based on their minimum emission standards as well as peak (06:30 to 10:00 am or 04:00 to 07:00 pm) and off-peak (10:00 am to 4:00 pm) time of entering/exiting the LECZ.

Several items related to the attitudes towards the LECZ system were also measured. Similar to the previous research, a variety of latent attitudinal factors, including distrust in the government (Kim et al., 2013), effectiveness (Sun et al., 2016), fairness (i.e., equity) (Cools et al., 2011), freedom (Sun et al., 2016), complexity of the scheme (Mehdizadeh & Shariat-Mohaymany,

2020), and environmental awareness (Cools et al., 2011) were assessed by several items. On a 5-point Likert scale (completely disagree, disagree, neutral, agree, & completely agree), distrust in government was evaluated by these three statements (see later, Table 2). Using two indicators, the perceived effectiveness was assessed on a 5-point Likert scale from "not at all effective" to "very effective". The respondents displayed their perception of the LECZ scheme fairness on a 5-point Likert scale ranging from "very unfair" to "very fair". Perceived freedom was also measured by two statements. The LECZ scheme complexity was explored by three items on a 5-point Likert scale (completely disagree, disagree, neutral, agree, & completely agree). Furthermore, the environmental awareness was also assessed by administering three items on a 5-point Likert scale (see items in Table 2). According to the existing scales (Alzahrani et al., 2019; Huang & Ge, 2019; Wang et al., 2016), different components of the TPB including subjective norms, attitudes, intention, and perceived behaviour control were adapted. The wording of some TPB statements was slightly modified for the HEVs' adoption, which was rated on a 5-point Likert scale from ''strongly disagree" to ''strongly agree". Attitude was also assessed by three items including "I support the country in introducing more policies to encourage individuals to adopt HEVs". Four items (e.g. "Most people who are important to me think I should adopt an HEV when adopting a vehicle in the near future") were used to measure subjective norms. Perceived behaviour control was evaluated by three statements (e.g. "The maintenance and repair of an HEV are important to me when I decide to adopt"). The intention was also evaluated by three items (e.g. I am willing to adopt an HEV when adopting a vehicle in the near future"). Profiles of attributes are indicated in details in Table 1.

Table 1. Profile of attributes in the tested model

Attribute	*n* (%)/*Mean* (*SD*)
Socioeconomic variables	
Age	39.90 (SD = 14.12)
Age group	
Age from 18 to 25 (*AGE_1825*)	101 (17%)
Age from 26 to 39 (*AGE_2639*)	220 (37%)
Age from 40 to 72 (*AGE_4072*)	274 (46%)
Gender (*MALE*) *n* (%)	369 (62%)
Well educated participant (*EDUCATION*) *n* (%)	339 (57%)
Full time job status (*OCCUPATION*) *n* (%)	315 (53%)
Greater than three members in household (*HHSIZE*) *n* (%)	292 (49%)
Owing at least two cars in household (*CAROWN*) *n* (%)	125 (21%)
High-income household	202 (34%)
Travel-related and built environment variables	
Driving time to the CBD is less than 15 min (*TTCAR_0015*) *n* (%)	89 (15%)
Driving time to the CBD is between 15 and 30 min (*TTCAR_1530*) *n* (%)	214 (36%)
Driving time to the CBD is more than 30 min (*TTCAR_30+*) *n* (%)	292 (49%)
Walking time to the closest public transport station is less than 10 min (*WTPT_010*) *n* (%)	268 (45%)
Walking time to the closest public transport station is 10 and more than 10 min (*WTPT_010+*) *n* (%)	327 (55%)

Making more than one day a week work trips to/from the CC (*WORK*) *n* (%)	292 (49%)
Making more than one day a week school trips to/from the CC (*SCHOOL*) *n* (%)	95 (16%)
Making more than one day a week shopping trips to/from the CC (*SHOPPING*) *n* (%)	196 (33%)
Making more than one day a week personal trips to/from the CC (*PERSONAL*) *n* (%)	268 (45%)
Making more than one day a week social trips to/from the CC (*SOCIAL*) *n* (%)	54 (9%)
Making more than one day a week entertainment trips to/from the CC (*ENTERTAINMENT*) *n* (%)	65 (11%)
Latent components related to the LECZ system	
The factor of distrust in government containing three statements (*DISTRUST*)	3.59 (SD =1.20)
The factor of effectiveness containing two statements (*EFFECTIVENESS*)	2.81 (SD =0.92)
The factor of fairness containing two statements (*FAIRNESS*)	2.61 (SD =1.11)
The factor of freedom containing two statements (*FREEDOM*)	3.01 (SD =0.95)
The factor of complexity of scheme containing three statements (*COMPLEXITY*)	3.35 (SD =1.08)
The factor of environmental awareness containing three statements (*ENVIRONMENT*)	2.97 (SD =1.34)
Latent factors related to the TPB with regards to HEVs adoption	
The component of attitudes towards HEVs adoption containing three items (*ATTHEVs*)	3.03 (SD =0.96)
The component of subjective norms in HEVs adoption containing four items (*SNHEVs*)	2.41 (SD =1.18)
The component of perceived behaviour control in HEVs adoption containing three items (*PBCHEVs*)	2.94 (SD =1.31)
The component of intention in HEVs adoption containing three items (*INTHEVs*)	3.06 (SD =0.98)

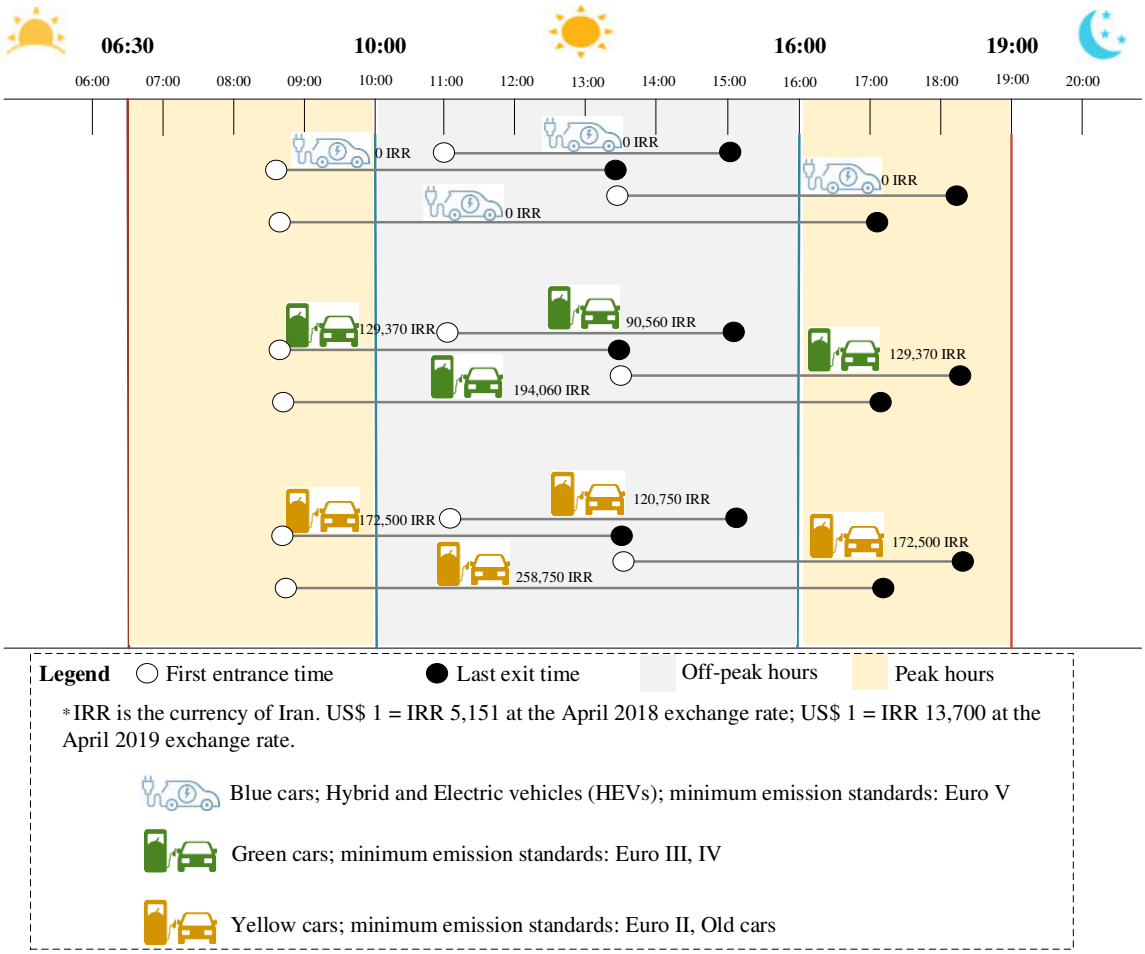


Fig 2. Proposed rules of the low emission charging zone (LECZ)

4.4. Descriptive statistics of respondents

Twenty-seven out of 622 subjects had not responded to the hypothetical referendum question. Thus, 595 confirmed responses were analysed (response rate=84%). The sample consisted of 226 females (38%) and 369 males (62%), which represented car users in Tehran. The age range of participants was18 to 72 (M=39.9, SD=14.2). Moreover, referendum results concerning the proposed LECZ system showed that 64.8% of respondents (n=386) were against the proposed scheme.

4.5. Modelling approach

To explain whether respondents vote for/against the proposed LECZ in a hypothetical referendum and distinguish those who vote for or against this scheme, a Hybrid Choice Model (HCM) was employed. This hybrid model tests the impact of latent psychological variables (i.e., the TPB related to the adoption of HEVs and attitudes towards the LECZ system) simultaneously, along with the observed characteristics of the choice ("Yes" or "No") in the hypothetical referendum. A discrete choice model and latent variables constitute the two main parts of an HCM-analysis (Cherchi et al., 2013; Mehdizadeh & Ermagun, 2018; Ben-Akiva et al., 2002).

4.5.1. Factor analysis

In order to identify factor solution for psychological items related to the LECZ system and the TPB (Kim et al., 2017; Mehdizadeh & Shariat-Mohaymany, 2020), Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA) was employed in this study. EFA was used to explore the underlying structures of the attitudes towards the LECZ system. Since the exact number of the TPB factors had been specified in previous studies, CFA was applied to test the consistency of the data with the well-known structure of the TPB. In EFA, Principal Component Analysis (PCA) with iteration and varimax rotation was carried out to identify the best factor solution. For the rotation method, first, an oblique rotation (the direct oblimin) method was applied to examine the possible correlation between factors. However, the results manifested the lack of correlation between factors (Tabachnick et al., 2007), suggesting an orthogonal rotation method (e.g. varimax). Moreover, pattern coefficients (i.e. loadings above 0.40) were regarded as a threshold for the items to retain various components. As for CFA, major fit indexes, including the Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI) were calculated (Kline, 2015). The RMSEA below 0.06 and TLI and CFI values between 0.90 and 0.95 indicate a good fit. Moreover, Cronbach's alpha (α) was calculated to determine the internal consistency of psychological measures.

Table 2 indicates the reliability and PCA indexes for the attitudes towards the LECZ system. As can be seen in Table 2, the reliability indexes of each category were desirable (α>0.70), and the

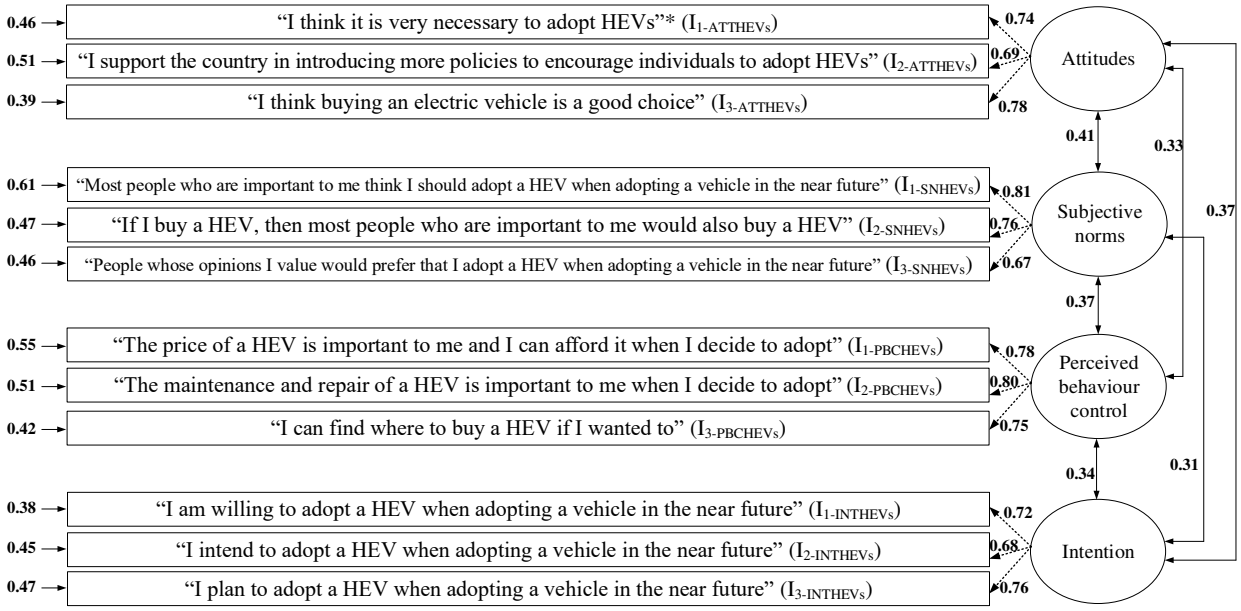
factor loadings of items were above 0.40, determining that all items maintained their corresponding construct.

Table 2. PCA and reliability indices for the attitudes towards the LECZ system

Dimensions	Factor loading
Complexity of scheme (α = 0. 784)	
"Details of the LECZ is too complex" ($I_{1\text{-COMPLEXITY}}$)	0.722
"I cannot understand the LECZ scheme well" ($I_{2\text{-COMPLEXITY}}$)	0.691
"Certain characteristics of the scheme, such as toll, period and type of vehicle are not clear" ($I_{3\text{-COMPLEXITY}}$)	0.672
Distrust in government (α = 0.837)	
"I distrust in government with respect to final use of LECZ revenues" ($I_{1\text{-DISTRUST}}$)*	0.840
"I think that the government do not use funds to improve public transport" ($I_{2\text{-DISTRUST}}$)	0.808
"I think that the government do not use funds to promote cleaner vehicles" ($I_{3\text{-DISTRUST}}$)	0.765
Effectiveness (α = 0.751)	
"To what extent do you perceive the LECZ to be effective?" ($I_{1\text{-EFFECTIVENESS}}$)	0.714
"To what extent do you perceive the LECZ will lead to an improved environment?" ($I_{2\text{-EFFECTIVENESS}}$)	0.682
Fairness (α = 0.810)	
"To what extent do you perceive the LECZ to be fair for you?" ($I_{1\text{-FAIRNESS}}$)	0.805
"To what extent do you perceive the LECZ to be fair for others?" ($I_{2\text{-FAIRNESS}}$)	0.793
Freedom (α = 0.749)	
"To what extent do you perceive the LECZ to affect your freedom to choose travel mode yourself?" ($I_{1\text{-FREEDOM}}$)	0.656
"Would the introduction of this measure make your personal daily trips more difficult?" ($I_{2\text{-FREEDOM}}$)	0.598
Environmental awareness (α = 0.821)	
"I have perceived traffic congestion" ($I_{1\text{-ENVIRONMENT}}$)	0.832
"I have perceived air pollution from gasoline-based cars" ($I_{2\text{-ENVIRONMENT}}$)	0.776
"I have perceived benefits of clean vehicles" ($I_{3\text{-ENVIRONMENT}}$)	0.752

* The items were used/modified from previous research (Cools et al., 2011; Grisolía et al., 2015; Sun et al., 2016).

Fig. 3 illustrates the result of CFA for the TPB related to the adoption of HEVs. The items were adopted from the studies of Huand and Ge (2019) and Wang et al. (2016). The primary CFA of the TPB scale was inconsistent with the data (χ^2= 168.43, p< 0.01, df= 59, RMSEA= 0.071, TLI= 0.89, CFI= 0.88). The modification of measurement model in subsequent analyses suggested that one item (which loaded on the subjective norm) had statistically non-significant loadings. After removing this item, the CFA fitted the data (χ^2= 108.21, p< 0.001, df= 48, RMSEA= 0.051, TLI= 0.91, CFI= 0.91). Regarding the internal consistency and scale reliability, the alpha of each TPB construct was higher than 0.70 (satisfactory).



Standardized coefficients, significant p < .001 coefficients in bold

χ^2= 108.22, df= 48, p< .001, RMSEA= .051, CFI= .91, TLI= .91

* The items were used from previous studies (Huang and Ge, 2019; Wang et al., 2016).

Fig 3. CFA results of the TPB related to HEVs adoption. Items adopted from Huand and Ge (2019) and Wang et al. (2016)

4.5.2. The Hybrid Choice Modelling (HCM)

We used PythonBiogeme (Bierlaire, 2016) to estimate the parameters of the developed HCM-framework. According to the hypothetical framework illustrated in Fig 1, we tested several models, including different direct and indirect relationships. Finally, the framework shown in Fig 4 was selected as the best model. The correlation coefficient of the study variables was also controlled. Of note, the correlation of Likert scales was tested by the Spearman rank-order correlation coefficient. According to Ben-Akiva et al. (2002), Cherchi et al. (2013), and Mehdizadeh et al. (2019b), the utility/disutility function of voting for/ against the LECZ depended on both observed and latent attributes. Given that the choice set was binary (yes/no) in the choice model, the utility of voting for the LECZ (voting "Yes"), as Train (2009) argues, was taken into account as the reference in the process of estimation. A complete mathematical description of the HCM is given in Appendix A.

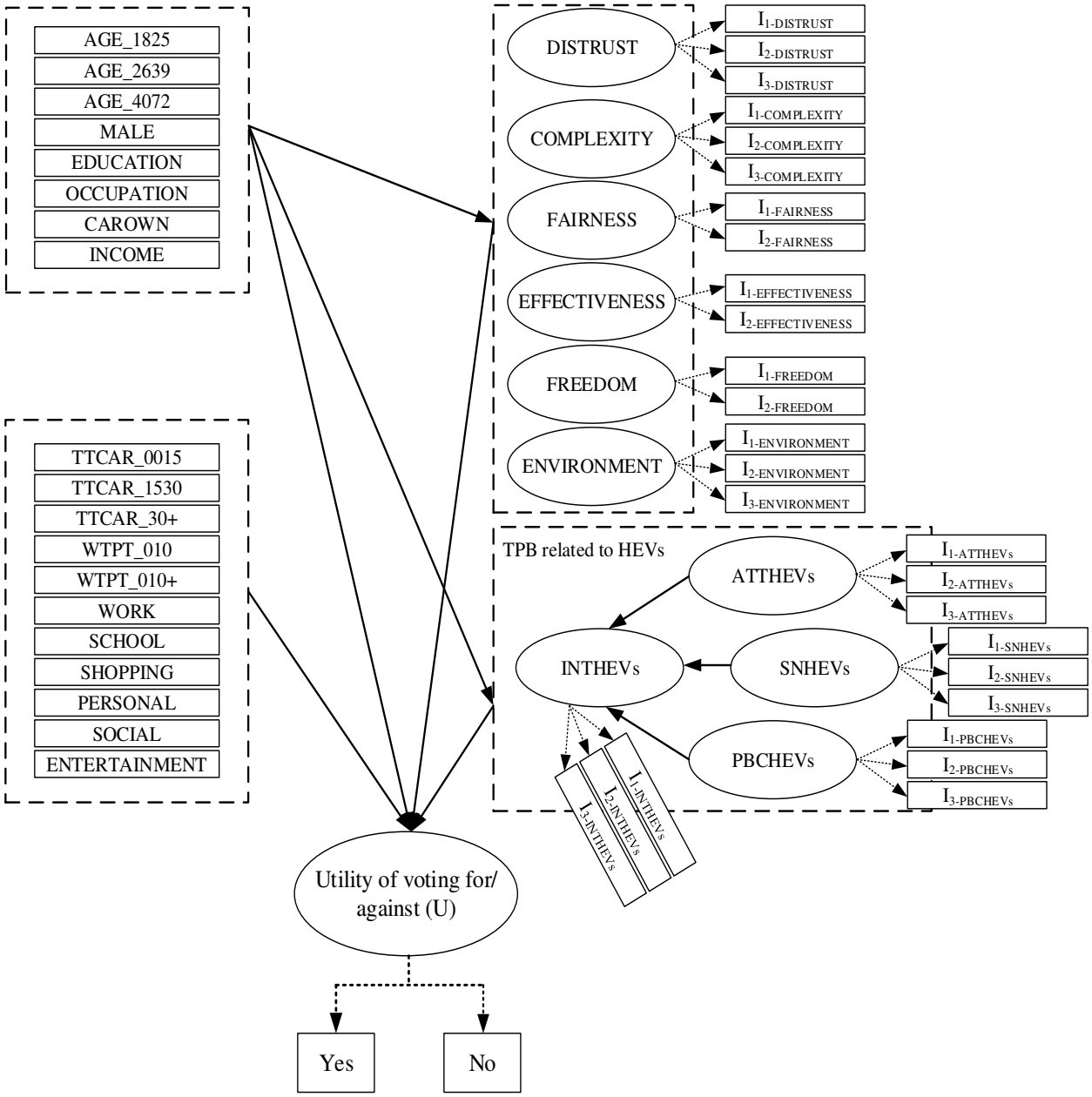


Fig 4. The estimated HCM-framework

5. Model estimation

Table 3 to 5 respectively indicate the model estimation of the choice, latent variable, and the measurement equation parts in the HCM-framework illustrated in Fig. 4. Among different estimated HCM-framework, the model with the highest significant coefficients and a confidence interval (CI) of 95% was chosen, and the overall goodness of fit was controlled. The likelihood ratio index is used to evaluate how well the discrete choice models fit the data (Train, 2009). As for the final estimated HCM-framework, the overall fit was 0.48.

Table 3. Participants that are likely to vote against (No =1) and for (Yes =0) the LECZ system (Discrete choice model of the HCM).

Attribute	Estimate	Robust t-test
Constant	1.57	3.65
Demographic and socioeconomic variables		
Age from 18 to 25	0.56	2.83
Age from 26 to 39	—	—
Age from 40 to 72	-0.44	-2.98
MALE	0.18	2.06
Well educated participant	-0.20	-2.42
Full time job status	—	—
Greater than three members in household	—	—
Owing at least two cars in household	0.11	1.99
High-income household	—	—
Travel-related and built environment variables		
Driving time to the CBD is less than 15 min	0.54	2.87
Driving time to the CBD is between 15 and 30 min	—	—
Driving time to the CBD is more than 30 min	—	—
Walking time to the closest public transport station is less than 10 min	-0.98	-2.76
Walking time to the closest public transport station is 10 and more than 10 min	—	—
Making more than one day a week work trips to/from the CC	0.60	2.54
Making more than one day a week school trips to/from the CC	—	—
Making more than one day a week shopping trips to/from the CC	0.49	2.73
Making more than one day a week personal trips to/from the CC	—	—
Making more than one day a week social trips to/from the CC	—	—
Making more than one day a week entertainment trips to/from the CC	—	—
Latent factors related to the LECZ system		
DISTRUST	1.86	3.12
EFFECTIVENESS	-1.67	-3.08
FAIRNESS	—	—
FREEDOM	0.83	2.51
COMPLEXITY	0.95	2.38
ENVIRONMENT	-1.49	-2.97
Latent factors related to the TPB with regards to HEVs adoption		
Attitudes	-0.76	-2.60
Subjective Norm	—	—
Perceived Behaviour Control	-0.48	-2.32
Intentions	-1.92	-3.38
Number of cases	595	
The model's Rho-square	0.48	

Table 4. The latent variable of the model's estimation results

Variables	Latent factors related to the LECZ system					
	DISTRUST	EFFECTIVENESS	FAIRNESS	FREEDOM	COMPLEXITY	ENVIRONMENT
Age from 18 to 25	1.18 (3.58)	—	-0.30 (-2.42)	—	—	—
Age from 26 to 39	—	—	—	—	—	—
Age from 40 to 72	—	—	—	—	0.29 (2.75)	0.70 (2.80)
MALE	—	-0.43 (-3.12)	—	—	—	-0.19 (-2.37)
Well educated participant	0.28 (2.66)	—	—	—	—	0.34 (2.84)
Full-time job status	—	—	—	0.78 (3.76)	—	—
Greater than three members in household	—	—	—	—	—	—
Owing at least two cars in household	—	—	—	—	—	—
High-income household	—	—	—	—	—	—
Random term	0.30 (9.12)	-0.79(-6.05)	-0.74 (-13.53)	0.21 (5.70)	0.49 (5.14)	0.46 (8.95)
	Latent factors related to the TPB with regards to HEVs adoption					
	Attitudes	Subjective Norm	Perceived Behaviour Control	Intentions		
Age from 18 to 25	0.68 (2.44)	—	—	0.82 (2.95)		
Age from 26 to 39	—	—	—	—		
Age from 40 to 72	—	-0.58 (-2.84)	—	—		
MALE	—	—	0.33 (2.15)	—		
Well educated participant	0.15 (1.98)	0.46 (2.78)	—	1.14 (3.26)		
Full time job status	—	—	—	—		
Greater than three members in household	—	—	—	—		
Owing at least two cars in household	—	—	—	—		
High-income household	—	—	—	0.81 (2.53)		
Attitudes	—	—	—	0.68 (2.48)		
Subjective Norm	—	—	—	—		
Perceived Behaviour Control	—	—	—	0.34 (2.25)		
Random term	0.12 (5.85)	-0.40 (-6.19)	0.28 (10.62)	0.70 (9.68)		

Note1. Values in parentheses are t-statistics.

Table 5. Estimation results of the measurement equation for latent variable

Latent variable	Indicator	Constant		Measurement parameter		Sigma	
		Estimate	t-test	Estimate	t-test	Estimate	t-test
DISTRUST	$I_{2\text{-DISTRUST}}$	-0.55	-3.82	1.80	18.04	0.14	4.95
	$I_{3\text{-DISTRUST}}$	-0.33	-6.97	1.34	13.78	0.50	8.66
EFFECTIVENESS	$I_{2\text{-EFFECTIVENESS}}$	-0.54	-5.23	1.36	30.66	-0.39	-6.82
FAIRNESS	$I_{2\text{-FAIRNESS}}$	0.62	4.78	2.41	13.55	0.13	3.25
FREEDOM	$I_{2\text{-FREEDOM}}$	-1.26	-7.34	3.10	15.60	-1.53	-4.01
COMPLEXITY	$I_{2\text{-COMPLEXITY}}$	-1.17	-8.23	1.82	28.90	-0.70	-6.42
	$I_{3\text{-COMPLEXITY}}$	-1.54	-10.08	1.95	19.16	-0.45	-6.38
ENVIRONMENT	$I_{2\text{-ENVIRONMENT}}$	-0.16	-2.92	1.57	7.19	-1.48	-14.20
	$I_{3\text{-ENVIRONMENT}}$	-0.29	-4.15	1.04	9.26	-0.94	10.98
ATTHEVs	$I_{2\text{-ATTHEVs}}$	-0.62	-4.25	1.17	14.54	0.16	9.68
	$I_{3\text{-ATTHEVs}}$	-0.26	-5.76	1.03	11.55	0.18	14.64
SNHEVs	$I_{2\text{-SNHEVs}}$	-1.31	-5.19	1.22	16.46	-0.56	-13.28
	$I_{3\text{-SNHEVs}}$	-1.15	-4.54	1.25	7.03	-0.72	-11.87
PBCHEVs	$I_{2\text{-PBCHEVs}}$	0.43	6.45	1.42	15.88	0.84	10.76
	$I_{3\text{-PBCHEVs}}$	0.84	3.27	1.38	12.66	0.80	7.54
INTHEVs	$I_{2\text{-INTHEVs}}$	-0.58	-7.40	2.64	21.32	-0.27	-8.65
	$I_{3\text{-INTHEVs}}$	-0.70	-6.55	2.59	14.37	-0.83	-11.40

Since variables in the final HCM analysis are either in dummy or Likert scales, the pseudo-elasticities were applied to investigate the relative roles of variables in changing the share of options (YES/NO). Regarding dummy variables, as illustrated in Fig 5, we calculated the mean share differences of the option "NO". For instance, the share of option "NO" was 1.08% higher in males than in females. As for latent variables, the estimated HCM was used to assess alteration in the share of options in nine policy scenarios (Table 6); that is, scenarios in which the latent psychological factors rise by one point for each related attitudinal or perceptual indicator. For example, an enhancement in effectiveness of the LECZ scheme increases the share of voting support from 35.4% to 41.2%.

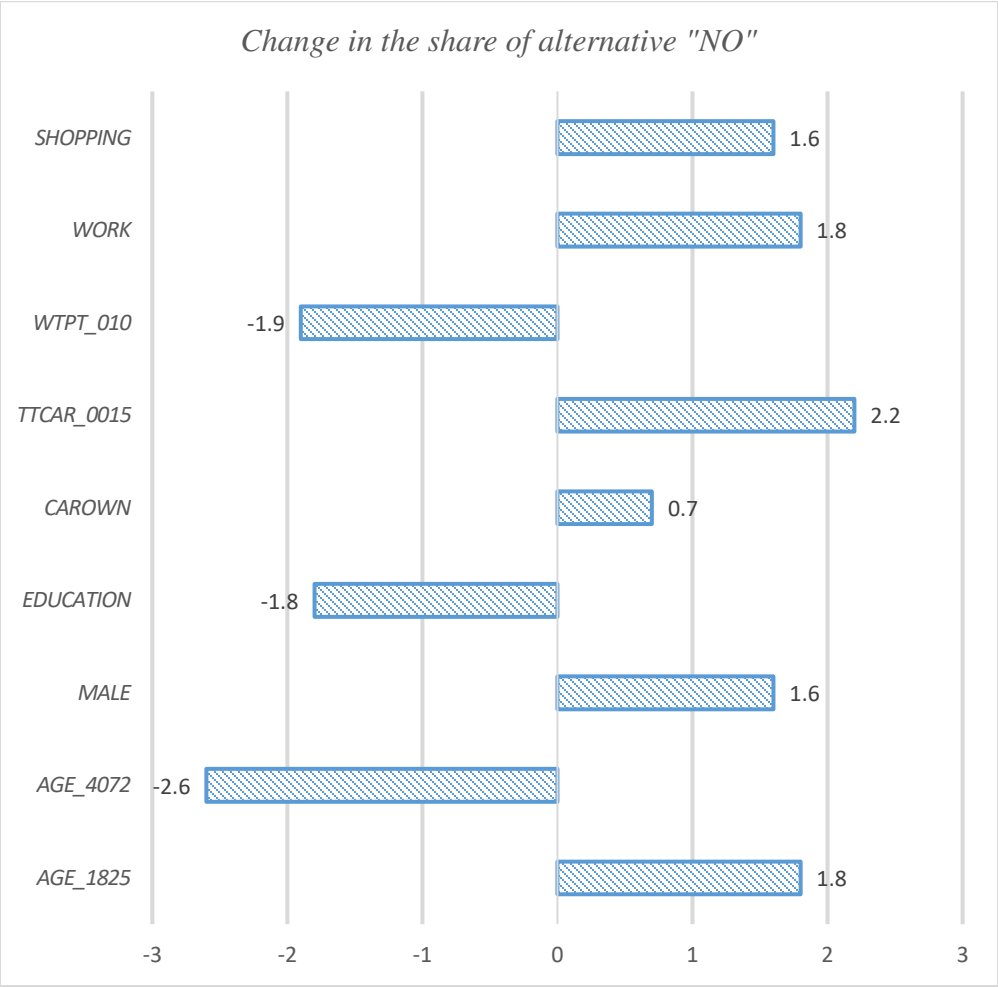


Fig 5. The results of pseudo-elasticities for dummy variables (share differences of the option "*NO*" between categories of dummy variables)

Table 6. Predicting changes in options (YES vs NO)

Scenario	Share of alternative (%)	
	NO	YES
Do Nothing	64.6*	35.4
A one-point increase in DISTRUST	71.7	28.3
A one-point increase in COMPLEXITY	68.1	31.9
A one-point increase in EFFECTIVENESS	58.8	41.2
A one-point increase in FREEDOM	65.9	34.1
A one-point increase in ENVIRONMENT	59.3	40.7
A one-point increase in ATTHEVs	63.4	36.6
A one-point increase in PBCHEVs	63.8	36.2
A one-point increase in INTHEVs	57.7	42.3

* The share of alternative is reported from the model output, not from the observation (the market share from the data).

6. Analysis of results and discussion

We empirically investigated the acceptability of a stricter pollution charging zone (the LECZ, which integrates LEZ and CC schemes) in a city where some traffic charging schemes were in place for years. In particular, the effects of four categories of explanatory variables including two latent variable sets, i.e. attitudes towards the proposed LECZ system and the adoption of hybrid and electric vehicles (HEVs) as well as two observed variable sets, i.e. socioeconomic variables and travel-related and built environment variables, were tested on voting for/against the LECZ system in a hypothetical referendum. Overall, the results suggested that the latent psychological features had a stronger impact on voting against the LECZ than other observed variables. According to the findings, among latent variables, distrust in government regarding the final use of the LECZ incomes and intention to adopt HEVs, had the most prominent effect on the likelihood of voting for/against the LECZ. A one-point increase in distrust and intention to adopt HEVs changed the share of option “NO” by 7.1% and -6.9%, respectively.

The results also indicated that around two-thirds of the participants voted against (“No”) the LECZ scheme. Previous studies have reported that the direct participating of citizens through referendum may guarantee the longstanding endurance of the pollution/congestion charge and its future functioning (Hensher, & Li, 2013; Hysing, 2015). Thus, identifying those who are likely to vote against such schemes has several policies and planning implications for a successful referendum. First, as far as attitudinal factors related to the LECZ system are concerned, it was found that citizens who distrust government in revenue allocation, think that the LECZ policy is ineffective, and that the details of the LECZ are too complicated, and those who are unaware of the environmental effects of pollution caused by motor vehicles were more likely to vote against the LECZ. The findings of this study are in line with the literature on CC/LEZ acceptance or acceptability. The findings, aligned with the previous studies, indicate that distrust in government (Mehdizadeh & Shariat-Mohaymany, 2020; Kim et al., 2013), uncertainty about the effectiveness of the proposed scheme to tackle traffic issues (Schade & Schlag, 2003), and weak

environmental concerns (Loukopoulos et al., 2005) are positively related to the rejection of CC/LEZ. In general, our findings imply that attitudinal predictors of a CC/LEZ acceptability and the LECZ could be fairly identical.

Second, in the proposed LECZ scheme, HEVs were allowed to travel freely in the zone. Regarding the relationship between the intentions to adopt HEVs and voting for/against the LECZ based on the theory of planned behaviour, we observed that most structural relationships underlying TPB and the desired behaviour (voting) were statistically significant. Individuals who had a stronger adoption intention were less likely to vote against the LECZ. Although attitudes and perceived behaviour control with regard to HEVs adoption were positively associated with both intention and voting behaviour, the subjective norm was neither related to intention nor to voting for/against. This indicates that from the participants' standpoint, there is a lack of social pressure regarding the adoption of HEVs. This highlights the role of other close family members colleagues and general media, which is linked to the herding phenomenon. Herd behaviour suggests that individuals are more inclined to mimic the behaviour of other people (Sun, 2013). A number of measures such as "creating contagious visual cues" and "reinforcing desired behaviours by showing that people like you tend to do so" could be taken to persuade herding behaviour related to HEVs adoption. However, the results revealed that people advocating policies related to HEVs promotion and those who can afford an HEV were less likely to vote against the LECZ scheme.

Third, consistent with our hypotheses, this study demonstrated that latent psychological factors, including attitudinal variables associated with the LECZ system and the TPB underlying HEV adoption, could mediate the relationship between socioeconomic attributes and voting for/against the LECZ scheme; that is, the relationship between socioeconomic variables and voting behaviour was extended by exploring several mediating and direct effects of psychological variables. The framework proposed in the present study can offer new insights into interrelationships of observed and latent variables. As for the correlates of attitudinal factors associated with the LECZ, the results revealed that well-educated and young respondents (i.e. 18–25 years old), were more likely to distrust the government in the LECZ revenue allocation. On the contrary, older respondents (above 40 years of age) were more likely to misunderstand particular features of the LECZ plan, including fees and period. Younger respondents (18-25 years old) believed that the proposed LECZ system was a relatively inequitable policy measure. Regarding effectiveness, females were more likely than males to think that the LECZ scheme will improve environment. Regarding freedom, full-time workers believed that the LECZ scheme would mount a challenge to the daily trip. Moreover, environmental awareness regarding the consequences of traffic congestion and benefits of clean vehicles was underlined by females, well-educated and older respondents (30-72 years old). Although awareness measurement was particularly limited to the environmental issues in this study, as argued by Balbontin et al.

(2017), awareness of what the proposed LECZ scheme is and familiarity with the debate on the system could also influence voting support.

Regarding the correlates of the TPB psychological constructs among socioeconomic variables, it is found that well-educated and younger respondents (18–25-year olds) were more likely to espouse the adoption of HEVs. Citizens who were younger than 25 years old and well-educated residents were more likely to report stronger subjective norm. Males reported a stronger perceived behaviour control when deciding to adopt HEVs. Furthermore, younger age (18–25-year olds) and high education, as well as high-income households, were positively related to a stronger intention to adopt.

Fourth, with regard to the correlates of voting for/against the LECZ among socioeconomic, travel-related and built environment variables, we found that participants' age significantly influenced voting for/against the scheme. Unlike previous research (Sun et al., 2016), the results revealed that older participants were less likely to reject the proposed LECZ in Tehran. The share of votes against the LECZ scheme by participants above 40 was 2.6% lower than people of other age groups. The findings of this study conflict with those of Jaensirisak et al. (2005) in the UK and Eliasson and Jonsson (2011) in Sweden, revealing that elders were more against the CC schemes.

Contrary to previous studies, we found a significant gender gap in the acceptability of the LECZ policy. According to our empirical findings, male gender was negatively associated with voting for the LECZ. Although income was not a significant variable in the HCM-analysis, people who owned two or more private cars were more likely to oppose the implementation of the LECZ. This is partially inconsistent with previous research, according to which high-income people are less likely to reject the CC scheme than respondents from low-income households (Verhoef et al., 1997). On the contrary, the walking distance to the closest public transport station and the travel distance from/to CBD by car were found to be significant predictors of voting behaviour. Citizens living near or inside the LECZ were more likely to vote against this scheme. Thus, it is recommended that policymakers offer some free tickets for public transit to these people or allocate a considerable daily discount for charges (Mehdizadeh and Shariat-Mohaymany, 2020). Accessibility of the public transit was also found to be a positive correlate of the LECZ acceptability. Therefore, people who had good access to public transit tended to support such schemes. One plausible explanation for this finding is that these people tend to change their means of transportation from cars to the public transit system. Moreover, results indicated that citizens who frequently had work and shopping trips from/to the CBD were more likely to vote against the LECZ. Therefore, future policies should focus on relocating shopping centres and workplaces outside the CBD besides encouraging telecommuting and e-shopping.

7. Summary, conclusions and policy implications

The present study is one of the first to investigate the psychology of public acceptability/rejection concerning combined congestion and low-emission charging zone (i.e. the LECZ) via a hypothetical referendum voting. Applying hybrid choice model, the influence of a wide range of factors regarding the latent attitudes, such as attitudes towards the proposed scheme and psychological constructs related to the adoption of HEVs, as well as socioeconomic, travel-related and built environment attributes were investigated. The current study addresses different aspects, including cleaner production (HEV adoption), environmental, and sustainability research. Furthermore, the study sample in Tehran has already been subjected to different CC and LEZ policies without any referendum. Hence, they might respond in a certain manner to a hypothetical referendum that basically combines the rules of an LEZ with CC.

- The upcoming policies and planning implications could be taken into account to promote the acceptability of the LECZ scheme in the study area. First, it seems that people distrust how the government will manage the proposed LECZ scheme and utilise its revenues. As asserted by Balbontin et al. (2017), an awareness of how the revenues of the proposed scheme are going to be spent is a key driver of support. Hence, it is important to dedicate ex-ante efforts to raise public awareness and familiarity with the notion and the debate of the LECZ system regarding revenue allocation and taxes (Hensher and Mulley, 2014). Other measures could also be taken to overcome the problem of public trust in the management system of the LECZ system. Governmental officials can report their measures and plans for the LECZ revenue allocation to the general public and their efforts to develop the public transport sector. Moreover, as argued by Hensher (2013), there is a positive association between voting intentions and public acceptability of the proposed scheme. Therefore, promoting public acceptability of new schemes (e.g. LECZ) through a trial ahead of an actual referendum can augment public support for such a scheme.
- Second, some groups of participants were more likely to oppose the LECZ because the proposed system was not straightforward and effective in their opinion. The integrated HCM-analysis proposed in this paper had several direct and indirect effects, which can help policymakers develop targeted policies according to citizen characteristics. For instance, the proposed system was reported to be complicated and effective by older citizens and males, respectively. Thus, some campaigns could be launched to address the issue of complexity and effectiveness of the LECZ system among older citizens and males. Using social networks and media, policymakers can conduct communication, information, and marketing campaigns. Given the dramatic growth of social networks such as Twitter, Instagram, and Telegram in Iran (Digital 2018; Mehdizadeh and Shariat-Mohaymany, 2020), campaigns can draw on above non-governmental media to raise public awareness about various facets of the LECZ system in Tehran.

- Third, in the proposed LECZ system, a large discount was considered for HEVs entering the charging zone. We found that underlying psychological constructs regarding the intention to adopt HEVs could explain voting for/against the LECZ system. However, among key factors, the subjective norm was significantly associated with neither intention nor acceptability/rejection of the LECZ. This finding may highlight the lack of social force by the society, friends and family members concerning the adoption of HEVs in Tehran. Several measures, such as HEVs exhibition and promotion of HEV-related incentive policy measures could be taken to tackle this problem in the study area. Furthermore, regarding the perceived behaviour control, respondents reported that if the price of HEVs, and the maintenance and repair of HEVs were affordable, they would be more likely to adopt and accept the LECZ system.
- Fourth, the expansion of public transit as well as promotion of e-shopping versus in-store shopping in the CBD may help increase the acceptability of the LECZ scheme in Tehran.

This study had a number of limitations that should be acknowledged. The data used in the study was collected using a cross-sectional and self-reported design. This design may be biased towards socially desirable responses and cast doubts on causal explanations between the attributes. Besides, since the empirical results of the current study are restricted to the data collected from the Middle East, caution should be exercised in generalising the results to other contexts. We also used the socioeconomic variables as linear in the utility function. As asserted by Ortúzar and Willumsen, (2011), considering interaction effects of level of service (LOS) attributes with socioeconomic variables as systematic taste variations may substantially improve model fit. However, we did not ask LOS attributes of the LECZ such as tolled charged, time-saving in our study survey (RP design). More recently, employing a stated choice (SC) experimental design, Ortúzar et al. (2021) have incorporated systematic taste variations on the acceptability of road pricing scheme for Santiago de Chile. Another limitation is that all respondents in our sample were car users, and in an actual referendum, non-car users may be more willing to accept the LECZ scheme. Moreover, participants with older cars would be more opposed to the LECZ system as they have to pay a higher fee. However, the data lack details of respondents' car.

Appendix A.

Utility function ($U_{n,No}$) can be expressed as Equation 1 (Mehdizadeh & Shariat-Mohaymany, 2020):

$$U_{n,No} = ASC_{No} + \beta_{No} SE_n + \theta_{No} BT_n + \lambda_z LV_{nz} + \varepsilon_{n,NO} \qquad (1)$$

where,

ASC_{No}: is the constant for the group that voted "No".

SE_n: is a vector of socioeconomic attributes.

BT_n: is a vector of travel-related and built environment attributes.

LV_{nz}: is z[th] latent variable.

$\varepsilon_{n,No}$: is the error term presumed to be identically and independently distributed (IID) extreme value type 1. Furthermore, β_{No}, θ_{No}, and λ_z are the respective parameters.

As noted by Mehdizadeh et al. (2019b), latent variables can be expressed according to Equation 2 via a series of Z structural equations:

$$LV_{nz} = \alpha_z SE'_n + \sum_{m \neq z} \vartheta_m LV_{nm} + \omega_{nz} \quad \forall z, m \in Z \tag{2}$$

where,

LV_{nz} and LV_{nm}: are latent factors z and m for person n.

SE': is a vector of socioeconomic variables related to z[th] latent variable.

α_z: is the coefficient vector corresponding to socioeconomic attributes.

ϑ_m: is the coefficient of the latent variable m, which is hierarchically associated with the latent variable z.

ω_{nz}: is an error term normally distributed with the standard deviation σ_{wz} and zero mean.

Considered as the measurement equation, the indicator of the latent variables is depicted in Equation 3:

$$I_{nkz} = \gamma_{kz} + \zeta_z LV_{nz} + \upsilon_{nkz}, \quad k = 1,...,K \tag{3}$$

where,

γ_{kz}: is the constant for the indicator k of latent variable z in the measurement equations.

ζ_z: is the coefficient associated with latent variable z.

υ_{nkz}: is an error term normally distributed with standard deviation $\sigma_{\upsilon z}$ and zero mean.

γ and ζ: are normalised to zero and one, respectively, for the primary indicator of each latent variables for the purposes of identification.

I_{nkz}: is the k[th] indicator for z[th] latent variable.

Considering the theory of random utility maximisation, Equation 4 can be used for the choice model:

$$y_{No,n} = \begin{Bmatrix} 1, \ if \ U_{No} > \left(U_{Yes,n}\right) \\ 0, \ otherwise \end{Bmatrix} \tag{4}$$

where,

$y_{No,n}$: characterise individual decisions, taking the value 1 "No" is selected (when it comes to the voting "and 0 for "Yes"" it takes the value 0).

For the dispersion of indicators and latent variables, Equations 5 and 6 were used:

$$f_{LV}\left(LV_{nz}\middle|SE_{nz},LV_{nm};\alpha_z,\vartheta_m,\sigma_{wz}\right)=\frac{1}{\sigma_{wz}}\phi\left(\frac{LV_{nz}-\left(\alpha_z SE_n'+\sum_{m\neq z}\vartheta_m LV_{nm}\right)}{\sigma_{wz}}\right) \quad (5)$$

$$f_I(I_{nz}|LV_{nz};\gamma_z,\zeta_Z,\sigma_{vz})=\frac{1}{\sigma_{vkz}}\varphi\left(\frac{I_{nz}-(\gamma_{kz}+\zeta_z LV_{nz})}{\sigma_{vz}}\right) \quad (6)$$

where,
ϕ: is the function of standard normal distribution.

In addition, Equation 7 illustrates the choice probability:

$$P_{n,No}=\int_{\omega}P_{n,No,z}\left(LV_{nz}(\omega_{nz})\right)f_{LV}(\omega_{nz})f_I\left(LV_{nz}(\omega_{nz})\right)f(\omega)d\omega \quad (7)$$

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